# 1986 PRODUCTS

- AEROSPACE/AVIATION
- AUTOMOTIVE/MOTOR VEHICLE
- ARCHITECTURAL/CONSTRUCTION
- ARTIFICIAL INTELLIGENCE
- BUSINESS
- BIOMEDICAL
- COMPUTER AIDED DESIGN
- CHEMICAL
- COMMUNICATIONS
- DESIGN/DEVELOPMENT ENGINEERING
- EDUCATION
- ELECTRONIC COMPONENTS
- ELECTRICAL EQUIPMENT
- ENGINEERING
- GOVERNMENT/DEFENSE
- LIGHT TECHNOLOGY
- MECHANICAL MEASUREMENTS
- MANUFACTURING/TEST
- MEDICAL/HEALTH
- PETROLEUM/ENERGY/NUCLEAR
- PUBLISHING
- QUALITY CONTROL/STANDARDS
- RESEARCH & DEVELOPMENT
- RADIO/MICROWAVE
- SCIENCE
- SERVICE
- TELEVISION/BROADCASTING

40 YEARS

Tektronix®

COMMITTED TO EXCELLENCE

## Front Cover

Tektronix' customer base has expanded substantially since we delivered our first oscilloscope to the University of Oregon Medical School in 1947. Our expanded markets are indicated on the cover. We've combined some markets and listed others in their broadest sense. As you might imagine, a complete application listing could fill the entire catalog, not just the cover.

## First 40 Years

February 2, 1986, marks the 40th anniversary of our corporate certification. The first oscilloscope, Type 511 was delivered the following May. You can review the highlights of these forty years, including many "firsts" on pages 460 and 461. But we're not resting on past performance. We're moving ahead in a number of areas. We are committed to maintaining and expanding our leadership.

## A Hint at the Future

There are more than 60 *NEW* hardware and software products in this catalog. They're identified by a bold color thumb tab on the upper page corner. You'll find a summary of our expanding software offerings on pages 25-26.

Tektronix has, through the years, invested a significant portion of our profits in product engineering. You'll see the results of innovative design in our new product offerings, all planned to make you more productive.

## Productivity

This is a key word at Tektronix.

We've prioritized productivity within our own plants and organizations. You benefit in increased value in Tek products (discussed further on pages 46, 85, 136 and 175). Your design and/or manufacturing organizations can now access our state-of-the-art components and custom design resources directly (see page 27).

You will also note an increased number of systems and system-compatible products in this catalog. A convenient "GPIB" thumb tab marks those pages listing products designed to work together over the IEEE-488 bus. The synergism of these products allows you to increase productivity, consistency and accuracy.

**This catalog belongs to**

_____

My Tektronix Contact
Business Card

Each Tek sales engineer specializes in the products and applications for a major area of customer activity: computer graphics, digital design and test, communications, and general test and measurement.

You can receive additional product information by calling your nearest Tektronix Sales Office listed on pages 462-465, or by returning the reply card in this catalog.

Many products listed in this catalog are available through the National Marketing Center by calling toll free 1-800-426-2200. In addition to being able to give you direct order entry, the NMC Sales Enginers are available to offer you immediate technical assistance about product specifications, capabilities and applications. They can send you literature, discuss available accessories, tell you about payment terms and options, or help you contact your local sales and service office.

# CONTENTS


IMPORTANT INFORMATION

INDEXES 2
GPIB PRODUCTS REFERENCE 13
COMPONENT DESIGN & PRODUCTION 27
DISPLAY TECHNOLOGY REFERENCE 40
WORKSTATION FURNITURE 83
CUSTOMER SERVICE INFORMATION 452
POWER SOURCE CONSIDERATIONS 459
TEKTRONIX 40 YEAR HIGHLIGHTS 460
SALES AND SERVICE OFFICES 462

INFORMATION DISPLAY

COMPUTER-AIDED ENGINEERING 44
INTELLIGENT GRAPHICS WORKSTATIONS/SOFTWARE 50
COMPUTER DISPLAY TERMINALS/SOFTWARE 57
LOCAL GRAPHICS PROCESSING UNIT 61
COLOR GRAPHICS WORKSTATIONS 64
ARTIFICIAL INTELLIGENCE SYSTEMS/SOFTWARE 70
GRAPHIC INPUT WORKSTATION 74
COLOR GRAPHICS COPIERS/HARD COPY UNITS 75
GRAPHIC TABLETS 79
SUPPLIES 80
DISPLAY PRODUCTS 81

DESIGN AUTOMATION

SOFTWARE DEVELOPMENT PRODUCTS 86
LOGIC ANALYZER PRODUCTS 101
SEMICONDUCTOR TEST SYSTEMS 132

COMMUNICATIONS

TELEVISION PRODUCTS 137
COMMUNICATION NETWORK ANALYZERS 150
SPECTRUM ANALYZER PRODUCTS 154

INSTRUMENTS/SYSTEMS

LABORATORY OSCILLOSCOPES 175
PORTABLE OSCILLOSCOPES 253
AUTOMATED TEST SYSTEMS 294
DIGITIZERS 306
ACQUISITION/PROCESSING SYSTEMS 330
TM 5000 GPIB PROGRAMMABLE PRODUCTS 338
TM 500 GENERAL PURPOSE PRODUCTS 357
CURVE TRACERS 393
CAMERAS, PROBES, CARTS, ACCESSORIES 403
PHOTOMETER/RADIOMETER 417

## A

**A to D Converter** ..... 7000 Series ..... 227
TM 5000 Series ..... 351
**Ac RMS Digital Voltmeters** ..... Portables ..... 272
TM 5000 Series ..... 344,364
**Accessories**
Cables ..... 448
GPIB Cables ..... 24
Probes ..... 446
Sampling ..... 7000 Series ..... 232-233
Spectrum Analyzer ..... 174
TM 5000, TM 500 Series ..... 390-392
Viewing ..... 451
**Accessory Power Supply** ..... 1101A ..... 435
**Acquisition/Processing Systems** ..... MP/MS Systems ..... 330
**Adaptors**
BNC, BSM, Cable Input, F, GR, N, Probe, Probe Grounding, Rack, SMA (3 mm) ..... 448-449
Camera Mounting ..... 406
Curve Tracer ..... 401
Fiber Optic ..... 151
Socket ..... 401
**Air Line, GR** ..... 448
**Amplifiers**
CATV Preamp ..... 7K11 ..... 167
Current Probe ..... 425,442
Differential ..... 7000 Series ..... 218
5000 Series ..... 249
TM 500 Series ..... 380
Differential Comparator ..... 7000 Series ..... 218
TM 5000 Series ..... 249
Dual Trace ..... 7000 Series ..... 215,232
5000 Series ..... 232,242, 248,252
Dual Trace Differential ..... 5000 Series ..... 250
Four Trace ..... 5000 Series ..... 248
Logic Triggered Vertical ..... 7000 Series ..... 216
Operational ..... TM 500 Series ..... 380
Programmable ..... 7000 Series ..... 323,325
Single Trace ..... 7000 Series ..... 213-219, 233-234
5000 Series ..... 248-250
Waveform Digitizer ..... 7000 Series ..... 315
5000 Series ..... 247
**Analyzers**
Audio ..... TM 5000 Series ..... 348
TM 500 Series ..... 376
Data ..... 103,127
Data Communications ..... 800 Series ..... 150
Distortion ..... TM 5000 Series ..... 348
TM 500 Series ..... 376
Logic ..... DAS 9100, 1200, 300 Series ..... 101
Spectrum ..... 490, 7000 Series ..... 154
Television Sideband ..... 1405 ..... 173
**Application Notes**
Photo/Radiometer ..... 421
Portable Oscilloscopes ..... 255
Probes ..... 425
7000 Series Oscilloscopes ..... 192
5000 Series Oscilloscopes ..... 240
**Artificial Intelligence Systems** ..... 4400 Series ..... 70
**Attenuators**
BNC, GR, N, SMA (3 mm) ..... 449
**Audio Analyzers** ..... TM 5000 Series ..... 348
TM 500 Series ..... 376
**Audio Channel Kit** ..... 144
**Audio Sweep Generator** ..... TM 5000 Series ..... 348
TM 500 Series ..... 378
**Audio Synchronizer** ..... 118-AS ..... 144
**Audio Test System, Programmable** TM 5000 Series ..... 348
**Automated Layout System** ..... Software ..... 48
**Automated Test Equipment** ..... S-Systems ..... 132
Digitizers ..... 294
MP/MS Systems ..... 337
**Automatic Frequency Measurement** Portables ..... 259
**Automatic Period, Pulsewidth and Time Measurements** ..... Portables ..... 259
**Automatic Risetime/Falltime Measurements** ..... Portables ..... 259
**Automatic Video Corrector** ..... 1440 ..... 148
**Automatic Video Measurement Set** 1980 ANSWER ..... 147
**Avionics Display** ..... 37

## B

**Battery Operated Oscilloscopes** ..... Portables ..... 253
**Battery Pack** ..... 141,281
**Battery Power Supply** ..... 281,391
**Bistable Storage Monitors** ..... GMA, 600 Series ..... 81
**Bistable Storage Oscilloscopes** ..... 7000 Series ..... 205-211
5000 Series ..... 241,245
TM 500 Series ..... 383
Portables ..... 288-293
**Blank Panel Plug-In Chassis** ..... 392
**BNC, BSM, Accessories** ..... 448

## C

**Cabinets, Plug-In Storage** ..... 450
**Cable Input Adaptors** ..... 448
**Cable Testing, Fault Locating**
Fiber Optic Bandwidth Test Set ..... 151
Fiber Optic TDR Testers ..... Portable ..... 150
Metallic TDR Testers ..... Portable ..... 153
7000 Series ..... 232
**Cables**
BNC, BSM, GR, N, SMA (3 mm) ..... 448
**CAD/CAM Workstations** ..... 6000 Series ..... 54
**CAE System** ..... 44
**Calibration Generators** ..... TM 500 Series ..... 385-387
**Calibration, Oscilloscope** ..... TM 500 Series ..... 385-387
**Calibration and Other Services** ..... 455
**Camera Carrying Cases** ..... 415
**Camera, Hand-Held** ..... 408
**Camera, Motorized Back** ..... 410
**Camera Mounting Adaptors** ..... 406
**Camera Writing Speed Enhancer** ..... 405
**Cameras, Scope/CRT Display** ..... 404-416
**Capacitors** ..... 36
**Capacitors, Coupling** ..... 449
**Cards**
Programmable A/D Converter ..... 351
Programmable D/A Converter ..... 351
Programmable Development ..... 353
Programmable Digital Input/Output ..... 351
Programmable Memory ..... 353
Programmable Relay Scanner ..... 352
**Carrying Cases, Camera** ..... 415
**Carrying Cases, Plug-In** ..... 174,451
**Carts, Lab/Portable Instruments** ..... 84,422
**Carts, Workstation** ..... 84
**CATV Preamp** ..... 167
**Chassis, Blank Panel Plug-In** ..... 392
**Circuit Boards**
Printed ..... 28
Flexible ..... 29
Teflon ..... 29
**Color Digital Analysis Mainframe** ..... DAS 9100 Series ..... 104-113
**Color Graphics Copiers** ..... 4600 Series ..... 75
**Color Graphics Terminals** ..... 4100, 4110, 4120 Series ..... 58
**Color Storage Oscilloscope** ..... 5000 Series ..... 246
**Color Television Picture Monitors** ..... 650 Series ..... 149
**Communications Test Equipment**
Analyzers
Data ..... 103,127
Sideband ..... 173
Spectrum ..... 490, 7000 Series ..... 154
Automatic Video Measurement Set ..... 1980 ANSWER ..... 147
Cable Fault-Locators ..... 152
Demodulators ..... 1450 Series ..... 146
Frequency Counters ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
Generators, Audio Sweep ..... TM 500 Series ..... 378
Noise Measurement Set ..... 148
Synchronizer ..... 144
TV Oscilloscopes ..... Portables ..... 288, 259,307

Vectorscopes ..... 1400, 500 Series ..... 142,143
VITS Inserters ..... 1900 Series ..... 145
148 Series ..... 148
Waveform Monitors ..... 1700, 1400 Series ..... 140
Camera and Mounting Adaptors ..... 406
CRT Phosphor Data ..... 180
CRT Storage Oscilloscopes ..... 182
Digital Storage Oscilloscopes and Waveform Digitizers ..... 182
Digital Counters ..... 358
Digital Multimeters ..... 363
Digital Photometer/Radiometer ..... 418
Digitizers ..... 306
Function Generators ..... 370
Logic Analyzers ..... 103
Modular Nonstorage Oscilloscopes ..... 181
Oscilloscope Calibration Product Guide ..... 385
Oscilloscope Cameras ..... 404
Portable Nonstorage Oscilloscopes ..... 181
Portable Oscilloscopes ..... 254
Power Supplies ..... 375
Probes ..... 426
Pulse Generators ..... 367
TM 500 Oscilloscopes ..... 381
7000 Series Oscilloscopes ..... 190
5000 Series Oscilloscopes ..... 239-240
**Components** ..... 27
**Component TV Generator** ..... 139
**Computer Controlled Oscilloscopes** MP Series ..... 330
**Computer Graphics Products**
Color Graphics Copiers ..... 4600 Series ..... 75
Computer Display ..... 4000 Series ..... 57-66
Display Monitors ..... GMA, 600 Series ..... 81,82
Graphic Software ..... 44, 52-56, 67-69
Graphic Tablet ..... 79
Hard Copy Units ..... 4600 Series ..... 78
Local Graphics Processing Unit ..... 61
Rasterizer ..... 75
Windowing ..... 4120 Series ..... 64
2D, 3D, 3D Shaded Capability ..... 4120 Series ..... 64
**Computer Graphics Supplies** ..... 80
**Connector Accessories** ..... 448
**Controller-Based Acquisition/ Processing Measurement Packages** ..... MP/MS Systems ..... 330
**Controller-Based Acquisition/ Processing Measurement Systems** MP/MS Systems ..... 330
**Controller, Programmable Switch** ..TM 500 Series ..... 355
**Controllers, System** ..... 298
**Constant Amplitude Generator** ..... TM 500 Series ..... 387
**Converters**
A to D ..... 7000 Series ..... 227
TM 500 Series ..... 351
D to A ..... TM 500 Series ..... 351
Electrical/Optical ..... 151
Optical/Electrical ..... 151
**Copier, Color Graphics** ..... 75
**Copy Units, Hard** ..... 78
**Cords, Patch** ..... 448
**Corrector, Automatic Video** ..... 148
**Counters, Digital**
Frequency ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
Time Interval ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
Universal ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
**Counter/Timer** ..... TM 500 Series ..... 362
**Counter/Timer/DMM Oscilloscope** Portables ..... 259,272
**Coupling Capacitors** ..... 449
**Covers, Protective** ..... 451
**Cradle Mount** ..... 450

**CRT**
Avionics ..... 37
Custom Design ..... 37
Light Filters, Mesh Filters ..... 451
Liquid Crystal Display ..... 38
Monochrome ..... 37
Readout Oscilloscopes ..... 7000 Series ..... 193-211
7000 Series, Digitizers ..... 318
5000 Series ..... 241,246
Portables ..... 259,313
**CRT Displays** (see Displays)
**Current Measuring Equipment** ..... 425
7000 Series ..... 227
TM 5000 Series ..... 249
TM 500 Series ..... 363,379 443
**Current Probe Amplifier** ..... TM 500 Series ..... 379,443
**Current Probes** ..... 379,425, 442-445
**Curve Tracer Adaptors** ..... 401
**Curve Tracer, Integrated Circuit** ..... 400
**Curve Tracers, Semiconductor** ..... 393

**D**
**D to A Converter** ..... 351
**Data Acquisition Modules** ..... 107
**Data Acquisition Probes** ..... 128
**Data Acquisition Systems** ..... MP/MS Systems ..... 330
**Data Analyzers** ..... 103,127
**Data Comm Analyzers, Testers** ..... 800 Series ..... 150
**Dc Inverter** ..... 282
**Delayed Sweep Oscilloscopes** ..... 7000 Series ..... 193-211, 220,223, 232,235, 318
5000 Series ..... 232,238, 252,241, 243
Digitizers ..... 256,318
**Delayed Sweep Sampling Plug-In** ..7000, 5000 Series ..... 232
**Delaying Time Bases** ..... 7000 Series ..... 220,223
7000, 5000 Series ..... 232
5000 Series ..... 243 252
**Demodulators, Television** ..... 146
**Designer's WorkSystem** ..... Software ..... 47
**Desktop Controller-Based Acquisition/Processing Systems** ...MP/MS Systems ..... 330
**Development Instruments, Digital** ..DAS 9100,1200, 300 Series . 101
**Development Unit, Multiuser Software** ..... 88
**Differential Amplifiers** ..... 7000 Series ..... 218
5000 Series ..... 249
TM 500 Series ..... 380
**Differential Comparator Amplifier** ..7000 Series ..... 218
5000 Series ..... 249
**Differential Input Oscilloscope** ..... 7000 Series ..... 193-211, 218,318
5000 Series ..... 238
Digitizers ..... 318,328
**Differential Amplifier, Dual Trace** ...5000 Series ..... 250
**Differential Probes** ..... 425,439
**Digital Analysis Mainframes** ..... DAS 9100 Series ..... 104-112
**Digital Counters** ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
**Digital Delay** ..... 7000 Series ..... 226
TM 500 ..... 374
**Digital Delay Oscilloscope** ..... 5000 Series ..... 193-211, 226,374
7000 Series, Digitizers ..... 318
**Digital Development Instruments** ...DAS 9100, 1200, 300 Series 101
**Digital Generator/Inserter** ..... 145
**Digital Input/Output Card** ..... TM 5000 Series ..... 351
**Digital Latches** ..... 101

**Digital Multimeters**
Autoranging ... Portables ... 264
Oscilloscope Coupled w/Temperature ... 7000 Series ... 225
Portables ... 264,288
DMM Oscilloscope ... 7000 Series ... 225
TM 5000 Series ... 344
TM 500 Series ... 363-365
Portables ... 259,268, 272,283, 285,288
**Digital Photometer/Radiometer** ... 417
**Digital Prescaler** ... TM 500 Series ... 343,361
**Digital Readout Oscilloscope** ... 7000 Series ... 193-211,
7000 Series, Digitizers ... 318
5000 Series ... 241,246
Portables ... 259-277, 283,288, 313
**Digital Servicing Aids** ... 127
**Digital Service Instrument** ... 127
**Digital Storage Oscilloscopes** ... Digitizers ... 254,307, 310,313, 318,328
**Digital Storage Spectrum Analyzers** 7000 Series ... 168
**Digital Tester** ... 800 Series ... 150
**Digital Voltmeters** ... TM 5000 Series ... 344
TM 500 Series ... 363-365
**Digitizers** ... 247, 306-329
**Digitizer Time Bases** ... 7000 Series ... 325,329
**Digitizing Oscilloscopes** ... Digitizers ... 306-329
**Disk Drive Unit** ... 301
**Display Monitors** ... GMA, 600 Series ... 81,82
**Displays (CRT)**
Bistable Storage ... GMA, 600 Series ... 81,82
Color Television Picture ... 149
Color Display ... 4000 Series ... 57-66
High Brightness ... 82
High Resolution ... 81
Large Screen ... 81
Liquid Crystal Shutter ... 38
Nonstorage ... 82
OEM ... 81-82
Raster Scan, Video ... 82
Storage Display ... 81
Television Waveform ... 142
Vector Display ... 142,143
X-Y ... 82
**Distortion Analyzers** ... TM 5000 Series ... 348
TM 500 Series ... 376
**DMM Oscilloscopes** ... 7000 Series ... 225
Portables ... 259,268, 272,283, 285,288
**Drafting Systems** ... 55,61
**Dual Beam Oscilloscopes** ... 7000 Series ... 203
5000 Series ... 244
**Dual Beam Storage Oscilloscopes** 5000 Series ... 244
**Dual Time Base (Mixed Sweep)** ... 7000 Series ... 222,225
5000 Series ... 251
**Dual Trace Amplifiers** ... 7000 Series ... 215
5000 Series ... 243,248 232
**Dual Trace Differential Amplifiers** 5000 Series ... 250
**Dual Trace Digital Storage Oscilloscope** ... Portables ... 313
**Dual Trace Oscilloscopes** ... 7000 Series ... 193-211
7000 Series, Digitizers ... 318
5000 Series ... 238
TM 500 Series ... 382-384
Portables ... 256-279, 283, 287-293

## E

**Events Delay** ... 226
**Extender, Multifunction Interface** ... TM 5000 Series ... 350

## F

**F Adaptors** ... 449
**Fast Rise Pulse Generator** ... 7000 Series ... 237
TM 500 Series ... 367-369
**Fast Transfer Storage Oscilloscopes** ... Portables ... 288
**Fault Locating Cable Testing** ... 150
**FET Probes** ... 425,435
**Fiber Optic Adaptors** ... 151
**Fiber Optic Bandwidth Test Set** ... 151
**Fiber Optic Cable Testers** ... 150
**Fiber Optic Electrical/Optical Optical/Electrical Converters** ... 151,390
**Filters**
Bandpass/Amplifier ... TM 500 Series ... 380
CRT Light, CRT Mesh ... 451
**Floating Measurements (Isolated)** ... 436-438
**Four Trace Amplifiers** ... 5000 Series ... 248
**Four Channel Oscilloscopes** ... Portables ... 259
**Frequency Counters** ... 7000 Series ... 228
TM 5000 Series ... 339
TM 500 Series ... 358
**Frequency Measurements, Automatic** ... Portables ... 259
**Full Custom WorkSystem** ... Software ... 48
**Function Cards** ... TM 5000 Series ... 351
**Function Generators** ... TM 5000 Series ... 345
TM 500 Series ... 370-373
**Furniture, Workstation** ... 83,84

## G

**Gate Array Layout WorkSystem** ... Software ... 48
**Generators, Signal**
Audio Sweep ... TM 5000 Series ... 348
TM 500 Series ... 378
Calibration ... TM 500 Series ... 385-387
Component TV ... 139
Constant Amplitude ... TM 500 Series ... 387
Fast Rise Pulse ... 7000 Series ... 237
TM 500 Series ... 367-369
Function ... TM 5000 Series ... 345
TM 500 Series ... 367-369
High Frequency ... TM 500 Series ... 368
NTSC ... 145
PAL and PAL-M ... 145
Pulse ... 7000 Series ... 237
TM 500 Series ... 367-369
Ramp ... TM 500 Series ... 367-369
Rate/Ramp ... TM 500 Series ... 367-369
RC Oscillator ... TM 500 Series ... 388
Sinewave ... TM 500 Series ... 370-373, 388
Squarewave ... TM 500 Series ... 372
Television Sync ... 1400 Series ... 145
Television Test ... 139, 144-148
Time-Mark ... TM 500 Series ... 387
Tracking ... TM 500 Series ... 172
Triangle ... TM 500 Series ... 372
Video Noise ... 148
**GPIB Products**
A to D Converter ... 7000 Series ... 227
TM 5000 Series ... 351
Acquisition/Processing Systems ... MP/MS Systems ... 330
Audio Test System ... TM 5000 Series ... 348
Cables ... 24
Calibration Generator ... TM 500 Series ... 385
Controller-Based Acquisition/Processing Measurement Systems ... MS Systems ... 330
Controllers ... 298
Counter/Timers ... TM 5000 Series ... 339
D to A Converter ... TM 5000 Series ... 351
Desktop Controller-Based Acquisition/Processing Measurement Packages ... MP Systems ... 330
Digital Multimeter ... TM 5000 Series ... 344
Digital Storage Oscilloscope ... Digitizers ... 254,307, 310,313, 318,328

Digitizers ..... 247, 306-329
Digitizer Systems ..... MP/MS Systems ..... 330
Digitizing Oscilloscopes ..... 307,310, 313,328
Distortion Analyzer ..... TM 5000 Series ..... 348
Interface ..... TM 5000 Series ..... 350
Logic Analyzer ..... 104
Multiplexer ..... TM 5000 Series ..... 355
Power Supplies ..... TM 5000 Series ..... 346,375
RF Scanner ..... TM 5000 Series ..... 354
Software ..... 305
Spectrum Analyzers ..... 490 Series ..... 154-164
Waveform Processing Oscilloscopes ..... 7000 Series, Digitizers ..... 318
Waveform Processing Systems ..... MP/MS Systems ..... 330
Workstations ..... 6000 Series ..... 24,55
**GPIB Reference** ..... 13-24
**GR Accessories** ..... 448
**Graphic Computer Terminals** ..... 4000 Series ..... 57-66
**Graphic Input Workstations** ..... 6000 Series ..... 72
**Graphic Presentation System** ..... 61
**Graphic Units, Interactive** ..... 50
**Graphics Processing Unit, Local** ..... 61
**Graphics Products, Computer** (see Computer Graphics Products)
**Graphics Software Library** ..... 67-69
**Ground Adaptors, Probe** ..... 451
**Ground Isolation Monitor** ..... 436
**Ground Leads, Probe** ..... 446

## H

**Hand-Held Camera** ..... 408
**Hard Copy Units** ..... 78
**Hard Copy Video Units** ..... 78
**High Brightness Monitor** ..... 82
**High Current Transformer** ..... 379,443, 445
**High Frequency Oscilloscopes** ..... 7000 Series ..... 193-211
Portables ..... 256-277
Digitizers ..... 307,310,
7000 Series, Digitizers ..... 318
**High Frequency Signal Generators** TM 500 Series ..... 368
**High Gain Oscilloscopes** ..... 7000 Series ..... 187-211
5000 Series ..... 238,241, 244-246
**High Resolution Copier** ..... 75
**High Resolution Monitor** ..... 81
**High Resolution Color Storage Scope** ..... 5000 Series ..... 246
**High Voltage Probe** ..... 366,426, 436-438, 440
**Hoods, Viewing** ..... 451
**Housing Accessory, BNC** ..... 448
**Hybrids** ..... 34

## I

**Image Forming Module** ..... 79
**Incoming Inspection Test Station** ..... MP Systems ..... 335
**Input Adaptors, Cable** ..... 448
**Input/Output Card, Digital** ..... TM 5000 Series ..... 351
**Inserters, VITS** ..... 145,148
**Instrument Carts, Mobile** ..... 83, 422-424
**Instrumentation, Programmable** ..... 13-24
490 Series ..... 155-164
TM 5000 Series ..... 355
TM 500 Series ..... 361
Digitizers ..... 306,321, 327
MP/MS System ..... 330
**Instrumentation Systems** ..... MP/MS Systems ..... 330
**Instrument Shuttle** ..... 422
**Instruments, Digital Service** ..... 127
**Instruments, Digital Development** ..... DAS 9100, 1200, 300 Series ..... 101
**Integrated Circuit Curve Tracer** ..... 400
**Integrated Circuit Test Equipment** ..... 132
**Integrated Circuits**
Quick Chip ..... 32
Microlith/Design ..... 33
**Integrated Counter/Timer/DMM Oscilloscope** ..... Portables ..... 272
**Intelligent Graphics Workstations** ..... 50
**Interactive Graphic Units** ..... 50
**Interface Extender, Multifunction** ..... TM 5000 Series ..... 350
**Interface, Programmable Multifunction** ..... TM 5000 Series ..... 350
**Inverter, Dc** ..... 282
**Isolated (Floating) Measurements** ..... 436-438

## L

**Lab/Portable Instrument Carts** ..... 422-424
**Laser Diode Module** ..... 35
**Leads, Patch Cord** ..... 448
**Leads, Probe Ground** ..... 446
**Library, Graphics Software** ..... 67-69
**Light Filters, CRT** ..... 451
**Light Measurement** ..... 417
**Liquid Crystal Display** ..... 38
**Local Graphics Processing Unit** ..... 61
**Local Programming** ..... Software ..... 67
**Locator, Cable Fault** ..... 152
**Logic Analyzers** ..... DAS 9100, 1200, 300 Series ..... 101
**Logic Probe** ..... 128
**Logic Triggered Vertical Amplifier** ..... 7000 Series ..... 216
**Low Frequency Oscilloscopes** ..... 5000 Series ..... 238-252
Portables ..... 278, 291-293
Digitizer, Portables ..... 310

## M

**Magnetic Components** ..... 36
**Mag Latch Relay** ..... 36
**Mainframes**
Color Digital Analysis ..... 104
General Purpose Instruments ..... TM 5000 Series ..... 355
TM 500 Series ..... 389
Logic Analyzer ..... 1200 Series ..... 114
**Matrix, Printer** ..... 51
**Matrix, Switch** ..... TM 5000 Series ..... 355
**Measurements**
Automatic Frequency ..... Portables ..... 259
Automatic Period, Pulse, Width and Time ..... Portables ..... 259
Automatic Video ..... 1980 ANSWER ..... 147
Current ..... 426
7000 Series ..... 225
5000 Series ..... 249
TM 500 Series ..... 364,379, 443
Isolated (Floating) ..... 436
Light ..... 417
Temperature ..... 366,442
TV Waveform ..... Portables ..... 259,307
**Memory Card, Programmable** ..... TM 5000 Series ..... 351-354
**MERLYN-G** ..... Software ..... 48
**MERLYN-PCB** ..... Software ..... 48
**Mesh Filters, CRT** ..... 451
**Metallic Cable Tester** ..... 153
7000 Series ..... 233
**Metals** ..... 31
**Microprocessor Support**
Logic Analyzers ..... 101
Software Development Products ..... 86
**Microwave, Spectrum Analyzers** ..... 154
**Military Designator Oscilloscopes** ..... Portables ..... 268,277, 274
**Mixed Sweep (Dual Time Base) Oscilloscopes** ..... 7000 Series ..... 222,224
5000 Series ..... 251
**Mixers, Waveguide** ..... 165
**Modular Probes** ..... 426, 430-433
**Modules, Data Acquisition** ..... 107
**Module, Image Forming** ..... 79

**Monitors**
Color Television Picture ..... 149
Color Display ..... 57-66
Computer Display ..... 57-66
High Brightness ..... 82
High Resolution ..... 81
Large Screen ..... 81
Nonstorage ..... 82
OEM ..... 81,82
Raster Scan, Video ..... 82
Storage Display ..... 81
Television Waveform ..... 142
Vector Display ..... 142,143
Waveform/Vector ..... 142,143
X-Y ..... 82
**Motorized Back Camera** ..... 410
**Mounting Adaptors, Camera** ..... 406
**Mounting Dimensions and Adaptors** ..... 450
**Multimeters, Digital** (see Digital Multimeters)
**Multimode Storage Oscilloscope** ...7000 Series ..... 182, 205-209
Portables ..... 288
**Multiplexer** ..... TM 5000 Series ..... 355

## N

**N Connector Cables and Adaptors** ..... 448
**Network Analyzers** ..... 152
**Noise Generator, Video** ..... 148
**Noise Measurement Set, Television** ..... 148
**NTSC Generators** ..... 145

## O

**OEM Products** ..... 50-79, 81,82, 404,422
**Operational Amplifier** ..... TM 500 Series ..... 380
**Oscillators** ..... TM 500 Series ..... 348,378, 388
**Oscilloscope Amplifiers** (see Plug-in Units)
**Oscilloscope Calibration Equipment** ..... TM 500 Series ..... 385-388
**Oscilloscope Cameras** ..... 404-416
**Oscilloscope Carts** ..... 422-424
**Oscilloscopes**
Battery Operated ..... 253
Calibrated (Mixed Sweep) ..... 7000 Series ..... 225
Portables ..... 288
Color Storage ..... 5000 Series ..... 246
Computer Controlled ..... MP Systems ..... 330
Counter/Timer/DMM ..... Portables ..... 272
Counter/Timer/Trigger ..... Portables ..... 259
Coupled with Temperature ..... 7000 Series ..... 225
Portables ..... 288
CRT Readout ..... 7000 Series ..... 193-211
7000 Series, Digitizers ..... 318
5000 Series ..... 241,246
Portables ..... 259,313
Curve Tracers ..... 393-402
Data Analyzer ..... 101
Delayed Sweep ..... 7000 Series ..... 193-211, 220,223, 232
7000 Series, Digitizers ..... 318
5000 Series ..... 232,252
Portables ..... 288
Differential Input ..... 7000 Series ..... 193-211, 218,318
5000 Series ..... 328
Digital Delay ..... 7000 Series ..... 193-211, 226,374
7000 Series, Digitizers ..... 318
Digital Readout ..... 7000 Series ..... 193-211
7000 Series, Digitizers ..... 318
5000 Series ..... 241,246
Portables ..... 259-277, 283,288, 313
Digital Storage ..... 254,307, 310,313, 328
7000 Series, Digitizers ..... 318
Digitizing ..... 254,307, 310,313, 318,328
DMM ..... 7000 Series ..... 225
Portables ..... 259,268, 272,283, 285,288
Dual Beam ..... 7000 Series ..... 203
5000 Series ..... 244
Dual Trace ..... 7000 Series ..... 193-211
7000 Series, Digitizers ..... 318
5000 Series ..... 238
Portables ..... 256-279, 283, 287-293
TM 500 Series ..... 382-384
Dual Trace Digital ..... Portables ..... 313
Four Channel ..... Portables ..... 259
High Frequency ..... 7000 Series ..... 193-211, 318
Portables ..... 256-277, 307,310
Digitizers ..... 310, 318
High Gain ..... 7000 Series ..... 187-211
5000 Series 238-241, 244-246
High Resolution Color Storage ..... 5000 Series ..... 246
Low Frequency ..... 5000 Series ..... 238-252
TM 500 ..... 381-384
Portables ..... 278,310 291-293
Military Designator AN/USM-488 ..... Portables ..... 268,274, 277
Mixed Sweep (Calibrated) ..... 7000 Series ..... 224
Portables ..... 288
Nonplug-in ..... Portables ..... 253-293
Plug-in ..... 7000 Series ..... 187-211
5000 Series ..... 238-252
TM 500 Series ..... 378, 381-384
Portable ..... 253-293
Programmable ..... 7000 Series ..... 315-320
Rackmount ..... 7000 Series ..... 194-198, 201-204, 208-211
5000 Series ..... 241,244
Portables ..... 258,267, 271,276
TM 5000 Series ..... 355
TM 500 Series ..... 381-384, 389
Ruggedized ..... Portables ..... 268,274, 277
Sampling Plug-in ..... 7000 Series ..... 230-237
Storage
Bistable ..... 7000 Series ..... 205-211
5000 Series ..... 241,245
Portables ..... 288-293
TM 500 Series ..... 383
Digital ..... 254, 307-313, 318,328
Dual Beam ..... 7000 Series ..... 203
5000 Series ..... 244
Fast Transfer ..... Portables ..... 288
Multimode ..... 7000 Series ..... 182, 205-209
Portables ..... 288
Reference Information ..... 205
Variable Persistence ..... 7000 Series ..... 205-211
5000 Series ..... 241
Portables ..... 288

Television ..... Portables ..... 259,288, 307
TM 500 ..... 381-384
Waveform Processing ..... MP/MS Systems ..... 330
Word Recognizer ..... Portables ..... 259,307
X-Y Plotting ..... 7000 Series ..... 193-211
5000 Series ..... 238,241, 244
Portables ..... 256,283, 278,
TM 500 Series ..... 384
**Output Module for Plotter or Chart Recorder** ..... 152

**P**

**Pack, Battery** ..... 141,281
**PAL and PAL-M Generators** ..... 145
**Panel Plug-In Chassis, Blank** ..... 392
**Patch Cords, Leads** ..... 448
**Pattern Generator Probes/Modules** ..... 101
**PCB WorkSystem** ..... Software ..... 49
**Performance Analysis (Software and Hardware)** ..... 117
**Period, Pulse, Width and Time Measurements, Automatic** ..... Portables ..... 259,307
**Photometer/Radiometer, Digital** ..... 417
**Plastics** ..... 30
**Plug-Ins**
General Purpose Instruments ..... TM 5000 Series ..... 338-356
TM 500 Series ..... 357-389
Oscilloscope ..... 7000 Series ..... 212-237
5000 Series ..... 242, 248-252
**Plug-In Carrying Cases** ..... 174,451
**Plug-In Chassis, Blank Panel** ..... 392
**Plug-In Storage Cabinets** ..... 450
**Plug-In Units**
Ac RMS Digital Voltmeter ..... Portables ..... 272
TM 5000 ..... 344
TM 500 ..... 364
Calibration Generators ..... TM 500 Series ..... 385-387
CATV Preamp ..... 167
Current Probe Amplifier ..... TM 500 Series ..... 379,443
Curve Tracers ..... 393
Delayed Sweep Sampler ..... 7000, 5000 Series ..... 232
Delaying Time Bases ..... 7000 Series ..... 220,223
5000 Series ..... 243,252
7000, 5000 Series ..... 232
Differential Amplifiers ..... 7000 Series ..... 218
5000 Series ..... 249
TM 500 Series ..... 380
Differential Comparator Amplifier ..... 7000 Series ..... 218
5000 Series ..... 249
Digital Counters ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
Digital Delay ..... 7000 Series ..... 226
TM 500 Series ..... 374
Digital Multimeters ..... 7000 Series ..... 225
TM 5000 Series ..... 344
TM 500 Series ..... 363-366
Digital Prescaler ..... TM 5000 Series ..... 343
TM 500 Series ..... 361
Digitizer Time Bases ..... 7000 Series ..... 325
5000 Series ..... 329
Dual Differential Amplifier ..... 5000 Series ..... 250
Dual Time Base (Mixed Sweep) ..... 7000 Series ..... 222,225
5000 Series ..... 251
Dual Trace Amplifiers ..... 7000 Series ..... 215
5000 Series 243,248
7000, 5000 Series ..... 232
Dual Trace Differential ..... 5000 Series ..... 250
Four Trace Amplifier ..... 5000 Series ..... 248
Logic Triggered Vertical Amplifier ..... 7000 Series ..... 216
Operational Amplifier ..... TM 500 Series ..... 380
Oscillators ..... TM 5000 Series ..... 348
TM 500 Series ..... 378,384, 388
Oscilloscopes ..... 7000 Series ..... 187-211
5000 Series ..... 238-252
TM 500 Series ..... 378, 381-384
Power Supplies
0 to 20 V Variable ..... TM 5000 Series ..... 346
TM 500 Series ..... 376
for Plug-In Units ..... TM 5000 Series ..... 355
TM 500 Series ..... 389
Programmable ..... TM 5000 Series ..... 346
Programmable ..... 7000 Series ..... 315,323, 325, 338-356
Programmable Distortion Analyzer ..... TM 5000 Series ..... 348
Ramp Generator ..... TM 500 Series ..... 370-373
Rate/Ramp Generator ..... TM 500 Series ..... 373
RF Sweep Generator ..... TM 500 Series ..... 388
Sample/Hold Digital Voltmeter ..... 7000 Series ..... 227
Sampling ..... 7000 Series ..... 230-237
5000 Series ..... 232
Sampling Heads ..... 7000 Series ..... 235-237
Single Time Bases ..... 7000 Series ..... 220,223, 234
5000 Series ..... 329,251
Single Trace Amplifier ..... 7000 Series ..... 213-219 233
5000 Series ..... 248-250
Spectrum Analyzers ..... 7000 Series ..... 166-171, 229
TDR ..... 7000 Series ..... 233
Tracking Generators ..... 172
Universal Counter/Timers ..... 7000 Series ..... 228
**Polarized Viewers** ..... 451
**Portable Instrument Carts, Lab** ..... 422
**Portable Oscilloscopes** ..... 253
**Portable Oscilloscopes w/Counter/Timer/Trigger** ..... 259
**Portable Oscilloscope w/DMM, Temp** ..... 259,288
**Portable Oscilloscope Power Supply** ..... 281
**Portable Spectrum Analyzer** ..... 490 Series ..... 155
**Power Divider, GR** ..... 448
**Power Divider, SMA (3 mm)** ..... 448
**Power Supplies**
0 to 20 V Variable ..... TM 500 Series ..... 346,376
Accessory ..... 435
Battery ..... 281,391
for Plug-In Units ..... TM 5000 Series ..... 355
TM 500 Series ..... 391
Portable Oscilloscope ..... 281
Programmable ..... TM 5000 Series ..... 346
**Preamp Amplifier, CATV** ..... 167
**Preamp, Spectrum Analyzer** ..... 167
**Prescaler, Digital** ..... TM 5000, TM 500 Series ..... 343
TM 500 Series ..... 361
**Printed Circuit Board Design System** ..... 48
**Printer, Matrix** ..... 51
**Probe Adaptors** ..... 448
**Probe Amplifiers, Current** ..... TM 500 Series ..... 379,443
**Probe Chart, Recommended** ..... 426-427
**Probe Ground Leads** ..... 448
**Probe Grounding Adaptors** ..... 448
**Probe Tips** ..... 446
**Probes**
Accessories ..... 446
Active ..... 426, 434
Counter ..... 361
Current ..... 379,426, 442
Data Acquisition ..... 128
Differential ..... 426,439, 249
Digital Photometer/Radiometer ..... 417-421
Environmental ..... 426,441, 442

**Probes (continued)**
FET and 50 Ohm ... 426,435
High Current ... 379,443
High Voltage ... 366,426, 440
Logic ... 128,441
Modular ... 426,430
Pattern Generator ... 128
Recommendations ... 426-428
RF ... 366,441
Temperature ... 366,442
Sampling ... 432
Voltage ... 426
Word Recognizer ... 128
**Programmable Instrumentation** (see GPIB Products)
**Protective Covers** ... 451
**Pulse Generators** ... 7000 Series ... 237
TM 500 Series ... 367-369

## R

**Rack Adaptors** ... 450
**Rackmount Model Instrument Carts** ... 422-424
**Rackmount Oscilloscopes** ... 7000 Series ... 194-198, 201-204, 208-211
5000 Series ... 241-244
TM 5000 Series ... 355
TM 500 Series ... 381-384
Portables ... 258,267 271-276
**Ramp Generators** ... TM 500 Series ... 370
**Raster Scan Display Units** ... 82
**Raster Scan/Video Hard Copy Units** ... 78
**Rasterizer** ... 75
**Rate/Ramp Generators** ... TM 500 Series ... 373
**RC Oscillator** ... TM 500 Series ... 388
**Readout Oscilloscopes, CRT** ... 7000 Series ... 193-211
7000 Series, Digitizers ... 318
5000 Series ... 241,246
Portables ... 259,313
**Readout Oscilloscopes, Digital** ... 7000 Series ... 193-211
7000 Series, Digitizers ... 318
5000 Series ... 241,246
Portables ... 259-277, 283,288
Portables, Digitizers ... 313
**Receivers, Optical/Electrical** ... 151
**Reference Information** (see Selection Guides)
Acquisition/Processing ... 330
Camera Recommendations ... 404-407
CRT Phosphors ... 180
Digitizers ... 306
Technology Section ... 39
General Purpose Interface Bus ... 13-24
Modular and Integrated Oscilloscopes ... 176
Oscilloscope Specifications ... 176
Probe Recommendations ... 426-428
Sales, Ordering, Customer Support ... 452-459
Sampling Applications ... 186,230
Storage Displays ... 182
Waveform Digitizers ... 186
**Reflectometer Cable Testing, Time Domain** ... 152
**Relational Data Base Management** 6000 Series ... 54
**RF Probe** ... 366,441
**Ruggedized Oscilloscopes** ... Portables ... 268,274, 277

## S

**Safety (Isolators)** ... 436
**Sample/Hold Digital Voltmeter** ... 7000 Series ... 227
**Sampler, Delayed Sweep** ... 7000, 5000 Series ... 232
**Sampling Accessories** ... 7000 Series ... 230-237
5000 Series ... 232
**Sampling Decision Tree** ... 230
**Sampling Heads Plug-In Units** ... 7000 Series ... 235-237
**Sampling Plug-In, Delayed Sweep** ... 7000, 5000 Series ... 232
**Sampling Plug-In Units** ... 7000 Series ... 232-237
5000 Series ... 232
**Sampling Probes** ... 432
**Scanner, Programmable** ... TM 5000 Series ... 354
**Scanner, Programmable Low Level** TM 5000 Series ... 352
**Selection Guides**
4100 Selection Guide ... 57
4120 Selection Guide ... 64
4400 Series Selection Guide ... 70
5000 Series Selection Guide ... 238
7000 Series Oscilloscope Systems/ Probe Selection Guide ... 191
7000 Series Nonstorage Selection Guide ... 193
Camera and Mounting Adaptor Selection Guide ... 406
Color Copier/Rasterizer Selection Guide ... 75
Digital Counters Selection Guide ... 358
Digital Multimeter Selection Guide ... 363
Logic Analyzer Selection Guide ... 103
Power Supplies Selection Guide ... 375
Portable Real Time Oscilloscope Selection Guide ... 254
Portable Storage Oscilloscope Selection Guide ... 254
Spectrum Analyzers Product Selection Guide ... 154
**Semiconductor**
Automatic Test Equipment ... S-Systems ... 132
MP/MS Systems ... 294,330
Curve Tracers ... 393
**Servicing Aids, Digital** ... 127,374
**Single Time Bases** ... 7000 Series ... 220,223, 234
5000 Series ... 329,251
**Sideband Analyzers, Television** ... 173
**Signal Generators**
(See Generator Signal)
**Signal Pickoff** ... 449
**Signal, TV Correctors** ... 148
**Single Trace Amplifiers** ... 7000 Series ... 213-219, 233
5000 Series ... 248-250
**SMA (3mm) Accessories** ... 448
**Socket Adaptors** ... 401
**Software Summary** ... 25-26
**Software Development WorkSystem** ... Software ... 49
**Software Development Unit, Multiuser** ... 88
**Spectrum Analyzers**
Accessories ... 174
Digital Storage ... 7000 Series ... 166,170
Plug-In ... 7000 Series ... 166-171, 229
Portable ... 490 Series ... 154
Preamp ... 167
Programmable ... 490P Series ... 154
**Standard Cell WorkSystem** ... Software ... 49
**Structured Custom WorkSystem** ... Software ... 48
**Storage**
Cabinets, Plug-In ... 450
Display Monitors ... 81
Oscilloscopes, Color ... 5000 Series ... 246
Oscilloscopes, Digital ... 307-314, 318,325
Oscilloscopes, Digitizing ... 307-314, 318,325
Spectrum Analyzers, Digital ... 7000 Series ... 166
**Sweep Generator, Audio** ... TM 5000 Series ... 348
TM 500 ... 378
**Swept Frequency Systems** ... 172
**Switch Controller, Programmable** ... TM 5000 Series ... 355
**Switch, Matrix** ... TM 5000 Series ... 355
**Sync Generator, Television** ... 145

**Synchronizers** ..... 144
**Systems**
Acquisition/Processing ..... MP/MS Systems ..... 330
Artificial Intelligence ..... 4400 Series ..... 70
Automated Layout ..... 48
Automatic Test ..... S-Systems ..... 132
CAE ..... 44
Data Acquisition ..... MP/MS Systems ..... 330
Desktop Controller-Based ..... MP/MS Systems ..... 330
Drafting ..... 55,61
Graphic ..... 50
Graphic Presentation ..... 61
Printed Circuit Board Design ..... 44
Programmable Audio Test ..... TM 5000 Series ..... 348
Swept Frequency ..... 172
Technical Data Analysis ..... 56
Test and Measurement ..... TM 5000, TM 500 Series, Digitizers, MP/MS Systems . 294-392
TV Waveform Measurement ..... Portables ..... 259,307
UNIX Software Development ..... 54

## T

**Technology Reference** ..... 39
**Television Products** (see full description in Television Catalog)
Audio Synchronizer ..... 144
Automatic Video Correctors ..... 148
Automatic Video Measurement Set ..... 147
Color Picture Monitor ..... 149
Demodulators ..... 146
Noise Measurement Set ..... 148
Oscilloscopes ..... 7000 Series ..... 224
Portables ..... 259,307, 288
Sideband Analyzers ..... 173
Signal Correctors ..... 148
Sync Generators ..... 145
Synchronizers ..... 144
Test Signal Generators ..... 139, 144-148
Vectorscopes ..... 142,143
VITS Inserters ..... 145,148
Waveform Monitors ..... 142,143
Waveform/Vector Monitors ..... 142,143
X-Y Monitor ..... 149
**Temperature Measurements** ..... 366, 442
**Temperature Probe** ..... 366, 442
**Terminals, Color Graphics Display** 4000 Series ..... 57-66
**Terminals, Graphic Computer** ..... 57-66
**Terminations, BNC, GR, SMA (3 mm)** ..... 448
**Test and Measurement Systems** ....TM 5000, TM 500 Series, Digitizers, MP/MS Systems . 294-392
**Test and Measurement Software WorkSystem** ..... Software ..... 49
**Test Equipment, Communications** (see Communications Test Equipment)
**Test Equipment, IC** ..... S-Systems ..... 132
**Test Signal Generators** ..... 139, 144-148
**Test Station, Incoming Inspection** .MP Systems ..... 335
**Test System, Automatic** ..... 132
**Test System, Programmable Audio** TM 5000 Series ..... 348
**Testers, Digital** ..... 150
**Testers, Fiber Optic Cable** ..... 152
**Testers, Metallic Cable** ..... 153
**Thermal Readout** ..... 7000 Series ..... 225
TM 500 Series ..... 363
Portables ..... 289
**Three-Dimensional Displays** ..... 4120 Series ..... 64
**Time Bases, Delaying** ..... 7000 Series ..... 220, 223
5000 Series ..... 243,252
7000, 5000 Series ..... 232
**Time Bases, Digitizer** ..... 7000 Series ..... 325
5000 Series ..... 329
**Time Bases, Dual (Mixed Sweep)** ..7000 Series ..... 222,225
5000 Series ..... 251
**Time Bases, Single** ..... 7000 Series ..... 220,223
5000 Series ..... 234,329, 251
**Time Domain Reflectometer, Cable Testing** ..... 152
**Time Interval Counters** ..... 7000 Series ..... 228
TM 5000 Series ..... 339
TM 500 Series ..... 358
**Time Mark Generator** ..... TM 500 Series ..... 387
**Tips, Probe** ..... 446
**Trace Recording Cameras** ..... 404-416
**Tracking Generators** ..... 172
**Transformers, High Current** ..... 379,443, 445
**Transistor Curve Tracers** ..... 393-402
**Transient Digitizer** ..... 321-327
**Transmitters, Electrical/Optical** ..... 151
**Triangle Generators** ..... TM 500 Series ..... 372
**Two-Dimensional Displays** ..... 4120 Series ..... 64

## U

**Universal Counter/Timers** ..... 7000 Series ..... 228
TM 5000 Series ..... 339-342
TM 500 Series ..... 358-362
**UNIX Software Development System** ..... 54

## V

**Variable Persistence Storage Oscilloscopes** ..... 7000 Series ..... 205-211
5000 Series ..... 241
Portables ..... 288
**Vectorscopes** ..... 1400, 500 Series ..... 142,143
**Video Corrector, Automatic** ..... 148
**Video Hard Copy Units** ..... 78
**Video Interface Kit** ..... 144
**Video Monitor, Raster Scan** ..... 149
**Video Noise Generator** ..... 148
**Viewing Hoods and Accessories** ..... 451
**VITS Inserters** ..... 1900 Series ..... 145,148
**Voltage Probes** ..... 426,441
**Voltmeter, Ac RMS Digital** ..... TM 5000 Series ..... 344
TM 500 Series ..... 363
Portables ..... 272
**Voltmeter, Sample/Hold Digital** .....7000 Series ..... 227

## W

**Waveform Digitizer Amplifier** .....5000 Series ..... 247
**Waveform Digitizer, Programmable** ..... 321-327
**Waveform Digitizing Instruments** ..... 306-337
**Waveform Monitors** ..... 1700, 1400 Series ..... 140
**Waveform Processing Oscilloscopes** ..... 7000 Series, Digitizers ..... 318
MP/MS Systems ..... 330
**Waveform/Vector Monitors** ..... 140,141
**Waveguide Mixers** ..... 165
**Window Managed Display** ..... 4120 Series ..... 64
**Windowing** ..... 4120 Series ..... 64
**Word Recognizer** ..... Portables ..... 259
**Word Recognizer Probe** ..... 128
**Workstation Furniture** ..... 83
**WorkSystems**
Designer's ..... Software ..... 47
Full Custom ..... Software ..... 48
Gate Array ..... Software ..... 48
PCB ..... Software ..... 49
Software Development ..... Software ..... 49
Standard Cell ..... Software ..... 49
Structured Custom ..... Software ..... 48
Test & Measurement ..... Software ..... 49
**Workstations**
CAD/CAM ..... 54
Color Graphics ..... 65,66
Graphic Input ..... 74
High Performance, 2D & 3D Intelligent Graphics ..... 6000 Series ..... 50
**Writing Speed Enhancers, Camera** ..... 405

## X

**X-Y Monitors** ..... 82

| Type | Instrument Description | Page |
|---|---|---|
| AA 501 | Distortion Analyzer | 376 |
| AA 5001 | Programmmable Distortion Analyzer | 348 |
| ACEDIT | ACE Screen Editor | 98 |
| ADS05 | Workstation Cart | 83 |
| AnthroCart | PC Cart | 83 |
| AnthroArm | Shelf Arm | 84 |
| AM 501 | Operational Amplifier | 380 |
| AM 502 | Differential Amplifier | 380 |
| AM 503 | Current-Probe Amplifier | 379,443 |
| AN/USM-488 | 100 MHz Dual Trace Portable Oscilloscope | 274,277 |
| A6302 | Current Probe | 379,443 |
| A6303 | Current Probe | 379,443 |
| A6741 | RS-499 Interface | 150 |
| A6742 | 2-Wire Direct Interface | 150 |
| A6743 | Tri-State Break-Out Box | 150 |
| A6744 | Interface Adaptor | 150 |
| A6901 | Ground Isolation Monitor | 438 |
| A6902B | Isolator | 437 |
| BP1 | Battery Pack | 141 |
| CAE | | 44 |
| CG 5001 | Programmable Oscilloscope Calibration Generator | 385 |
| CG 551AP | Programmable Oscilloscope Calibration Generator | 385 |
| ColorKey | Interface Software | 93 |
| Common LISP | Software | 73 |
| CT-1 | Current Transformer | 445 |
| CT-2 | Current Transformer | 445 |
| CT-3 | Signal Pickoff | 445 |
| CT-5 | Current Transformer | 445 |
| C-30B | Camera | 412 |
| C-31B | Camera | 412 |
| C-4 | Camera | 408 |
| C-5C | Camera | 416 |
| C-51 | Camera | 413 |
| C-53 | Camera | 413 |
| C-59A | Camera | 415 |
| C-7 | Camera | 410 |
| CX4106A | Computer Display Terminal | 60 |
| CX4107A | Computer Display Terminal | 60 |
| CX4109A | Computer Display Terminal | 60 |
| DAS 91XX | Digital Analysis Systems | 111 |
| DAS 9109 | Digital Analysis Mainframe | 111 |
| DAS 9119 | Digital Analysis Mainframe (ATE Version) | 111 |
| DAS 9129 | Color Digital Analysis Mainframe | 111 |
| DC 5009 | Programmable 135 MHz Universal Counter/Timer | 342 |
| DC 5010 | Programmable 350 MHz Universal Counter/Timer | 340 |
| DC 503A | 125 MHz Universal Counter | 360 |
| DC 504A | 100 MHz Counter/Timer | 362 |
| DC 509 | 135 MHz Universal Counter/Timer | 359 |
| DC 510 | 350 MHz Universal Counter/Timer | 359 |
| DDL | Digital Design Lab Support | 98 |
| DD 501 | Digital Delay | 374 |
| DM 44 | Digital Multimeter | 289 |
| DM 501A | Digital Multimeter | 364 |
| DM 5010 | Programmable Digital Multimeter | 344 |
| DM 502A | Autoranging Digital Multimeter | 364 |
| DP 501 | Digital Prescaler | 343,361 |
| EZ-TEST | Software | 304 |
| FA-1 | Fiber Adaptors | 152 |
| FA-2 | Fiber Adaptors | 152 |
| FA-3 | Fiber Adaptors | 152 |
| FA-4 | Fiber Adaptors | 152 |
| FA-5 | Fiber Adaptors | 152 |
| FA-6 | Fiber Adaptors | 152 |
| FA-7 | Fiber Adaptors | 152 |
| FG 501A | 2 MHz Function Generator | 372 |
| FG 5010 | Programmable 20 MHz Function Generator | 345 |
| FG 502 | 11 MHz Function Generator | 372 |
| FG 503 | 3 MHz Function Generator | 372 |
| FG 504 | 40 MHz Function Generator | 373 |
| FG 504T | 40 MHz Function Generator | 373 |
| FG 507 | 2 MHz Sweeping Function Generator | 373 |
| Franz LISP | Software | 73 |
| GMA201 | Computer Display Module | 81 |
| GRASP | Software | 158 |
| GURU | Software | 305 |
| ICOM40 | Interface Software | 98 |
| J16 | Digital Photometer/ Radiometer | 417 |
| J6501 | Illuminance Probe | 419 |
| J6502 | Irradiance Probe | 419 |
| J6503 | 8° Luminance Probe | 419 |
| J6504 | Uncorrected Probe | 420 |
| J6505 | LED Probe | 419 |
| J6511 | Illuminance Probe | 419 |
| J6512 | Irradiance Probe | 419 |
| J6523 | 1° Luminance Probe | 420 |
| K117 | Instrument Shuttle | 423 |
| K212 | Portable Instrument Cart | 423 |
| K213 | Lab Instrument Cart | 424 |
| K217 | Rack Instrument Cart | 424 |
| LANDS | Language Development Systems | 90 |
| Lo Pro | Software | 67 |
| MERLYN-G | Automated Layout System | 48 |
| MERLYN-PCB | Printed Circuit Board Design System | 48 |
| MI 5010 | Programmable Multifunction Interface | 350 |
| MProlog | Software | 72 |
| MP 1101 | Programmable Digitizer Measurement Package | 332 |
| MP 1201 | Programmable Digitizer Measurement Package | 332 |
| MP 2101 | Acquisition/Processing Measurement Package | 332 |
| MP 2201 | Acquisition/Processing Measurement Package | 332 |
| MP 2401 | Acquisition/Processing Measurement Package | 332 |
| MP 2501 | Acquisition/Processing Measurement Package | 334 |
| MP 2601 | Portable Measurement Package | 334 |
| MP 2901 | Inspection Test Station | 335 |
| MP 2902 | Audio Measurements Package | 335 |
| MP 2903 | Oscilloscope Measurement Package | 336 |
| MS 3101 | Acquisition/Processing Measurement System | 337 |
| MS 3201 | Acquisition/Processing Measurement System | 337 |
| MX 5010 | Interface Extender | 350 |
| M2 | Sample/Hold Module | 227 |
| OF150 | Fiber Optic TDR | 150 |
| OF151 | Fiber Optic TDR | 150 |
| OF152 | Fiber Optic TDR | 150 |
| OF192 | Fiber Optic TDR Bandwidth Test Set | 151 |
| OF235 | Fiber Optic TDR | 150 |
| OR501 | Receivers | 151 |
| OR502 | Receivers | 151 |
| OT501 | Transmitters | 151 |
| OT502 | Transmitters | 151 |
| OT503 | Transmitters | 151 |
| PG 501 | 50 MHz Pulse Generator | 369 |
| PG 502 | 250 MHz Pulse Generator | 369 |
| PG 506 | Calibration Generator | 387 |
| PG 507 | Dual Output 50 MHz Pulse Generator | 368 |
| PG 508 | 50 MHz Pulse Generator | 368 |
| PG 508T | 50 MHz Pulse Generator | 368 |
| PLOT 10 | Graphics Software Library | 68 |
| PS 5004 | Power Supply | 346 |
| PS 5010 | Programmable Triple Power Supply | 347 |
| PS 501-1 | Power Supply | 376 |
| PS 503A | Triple Power Supply | 376 |
| P6006 | 10X Probe | 429 |
| P6007 | 100X Probe | 440 |
| P6008 | 10X Probe | 441 |
| P6009 | 100X Probe | 440 |
| P6010 | 10X Probe | 429 |
| P6015 | 1000X Probe | 440 |
| P6021 | Current Probe | 444 |
| P6022 | Current Probe | 444 |
| P6028 | 1X Probe | 429 |
| P6046 | FET Differential Probe | 439 |
| P6048 | 10X Probe | 431 |
| P6053B | 10X Probe | 432 |
| P6055 | 10X Probe | 439 |
| P6056 | 10X Probe | 432 |
| P6057 | 100X Probe | 432 |
| P6062B | 10X or 1X Probe | 432 |
| P6063B | 10X or 1X Probe | 432 |
| P6101A | 1X Probe | 430 |
| P6102A | 10X Probe | 247,430 |
| P6104A | Voltage Probe | 430 |
| P6105A | 10X Probe | 430 |
| P6106A | 10X Probe | 430 |
| P6107A | 10X Probe | 430 |
| P6108A | 10X Probe | 430 |
| P6121 | 10X Probe | 431 |
| P6122 | 10X Probe | 431 |
| P6125 | 5X Counter Probe | 431 |
| P6130 | 10X Probe | 433 |
| P6131 | 10X Probe | 433 |
| P6133 | 10X Probe | 433 |
| P6149A | 10X Probe | 430 |
| P6201 | FET Probe | 435 |
| P6202A | FET Probe | 435 |
| P6230 | 10X Probe | 434 |
| P6302 | Current Probe (See A6302) | 443 |
| P6303 | Current Probe (See A6303) | 443 |
| P6401 | Logic Probe | 441 |
| P6406 | Word Recognizer Probe | 128 |
| P6420 | 1X RF Probe | 441 |
| P6430 | Temperature Probe | 128 |
| P6451 | Data Acquisition Probe | 128 |
| P6452 | Data Acquisition Probe | 128 |
| P6453 | High-Speed Data Acquisition Probe | 128 |
| P6454 | 100 MHz Clock Probe | 128 |
| P6455 | TTL/MOS Pattern Generator Probe | 128 |
| P6456 | ECL Pattern Generator Probe | 128 |
| P6457 | Pattern Generator Probe | 128 |
| P6460 | Data Acquisition Probe | 128 |

| Type | Instrument Description | Page |
|---|---|---|
| P6462 | Data Acquisition Probe | 128 |
| P6601 | Temperature Probe | 366 |
| P6602 | Temperature Probe | 442 |
| SC 501 | 5 MHz Oscilloscope | 381 |
| SC 502 | 15 MHz Dual Trace Oscilloscope | 384 |
| SC 503 | 10 MHz Storage Oscilloscope | 383 |
| SC 504 | 80 MHz Oscilloscope | 382 |
| SG 502 | RC Oscillator | 388 |
| SG 503 | Leveled Sinewave Generator | 388 |
| SG 504 | Leveled Sinewave Generator | 388 |
| SG 505 | Oscillator | 388 |
| SG 5010 | Programmable Oscillator | 348 |
| SI 5010 | Programmable Scanner | 354 |
| SPG12 | TV Sync Generator | 145 |
| SPG2 | TV Sync Generator | 145 |
| SPG22 | TV Sync Generator | 145 |
| STRUCTA | Structured Analysis Tool | 88 |
| S-1 | Sampling Head | 235 |
| S-2 | Sampling Head | 235 |
| S26RF00 | Software | 158 |
| S-3A | Sampling Head | 235 |
| S-3220 | LSI Test System | 135 |
| S-3225 | Test System | 133 |
| S-3270 | LSI Test System | 135 |
| S-3280 | ECL Test System | 135 |
| S-3295 | VLSI Test System | 134 |
| S-4 | Sampling Head | 236 |
| S-5 | Sampling Head | 236 |
| S-6 | Sampling Head | 236 |
| S-51 | Trigger Countdown Head | 236 |
| S-52 | Pulse Generator Head | 237 |
| S-53 | Trigger Recognizer Head | 237 |
| S-54 | Pulse Generator Head | 237 |
| TDC | TV Down Converter | 147 |
| TDC-1 | TV Down Converter | 147 |
| TDC-2 | TV Down Converter | 147 |
| TekMate | Software | 94 |
| TekSPANS | Software | 158 |
| TG 501 | Time Mark Generator | 387 |
| TM 5003 | Three-Wide Mainframe | 355 |
| TM 5006 | Six-Wide Mainframe | 355 |
| TM 501 | One-Wide Mainframe | 389 |
| TM 503 | Three-Wide Mainframe | 389 |
| TM 504 | Four-Wide Mainframe | 389 |
| TM 506 | Six-Wide Mainframe | 389 |
| RTM 506 | Six-Wide Mainframe | 389 |
| TM 515 | Five-Wide Mainframe | 389 |
| TR 502 | Tracking Generator | 172 |
| TR 503 | Tracking Generator | 172 |
| TSG11 | TV Test Signal Generator | 145 |
| TSG12 | TV Test Signal Generator | 145 |
| TSG13 | TV Test Signal Generator | 145 |
| TSG15 | TV Test Signal Generator | 145 |
| TSG16 | TV Test Signal Generator | 145 |
| TSG170A | TV Test Signal Generator | 139 |
| TSG2 | TV Test Signal Generator | 145 |
| TSG21 | TV Test Signal Generator | 145 |
| TSG23 | TV Test Signal Generator | 145 |
| TSG25 | TV Test Signal Generator | 145 |
| TSG26 | TV Test Signal Generator | 145 |
| TSG3 | TV Test Signal Generator | 145 |
| TSG300 | Component TV Generator | 139 |
| TSG5 | TV Test Signal Generator | 145 |
| TSG6 | TV Test Signal Generator | 145 |
| TSG7 | TV Test Signal Generator | 145 |
| TSP1 | TV Signal Processor | 145 |
| TSP11 | TV Signal Processor | 145 |
| TSP21 | TV Signal Processor | 145 |
| V-Systems | Emulation Support | 98 |
| XY1 | Output Module | 152 |
| 110-RC | Remote Control Unit | 144 |
| 110-S | Synchronizer | 144 |
| 1101A | Probe Power Supply | 435 |
| 1105 | Battery Power Supply | 281,390 |
| 1106 | Battery Pack | 281 |
| 1107 | Dc Inverter | 282 |
| 118AS | Audio Synchronizer | 144 |
| 118F01 | Audio Channel Kit | 144 |
| 118F02 | Video Interface Kit | 144 |
| 118-RC | Remote Control Unit | 144 |
| 12R01 | Performance Analysis Module | 117 |
| 1240 | Logic Analyzer Mainframe | 114 |
| 1241 | Color Logic Analyzer Mainframe | 114 |
| 134 | Current Probe Amplifier | 444 |
| 1360P | Programmable Switch Controller | 355 |
| 1360S | Switch Matrix | 355 |
| 1405 | TV Sideband Adaptor | 173 |
| 1410R | NTSC Mainframe | 145 |
| 1411R | PAL Mainframe | 145 |
| 1412R | PAL-M Mainframe | 145 |
| 1420 | TV Vectorscope | 143 |
| 1421 | TV Vectorscope | 143 |
| 1422 | TV Vectorscope | 143 |
| 1430 | TV Noise Measurement Set | 148 |
| 1434 | Video Noise Generator | 148 |
| 1440 | Automatic Video Corrector | 148 |
| 1450-1 | TV Demodulator Mainframe | 146 |
| 1450-2 | TV Demodulator Mainframe | 146 |
| 1450-3 | TV Demodulator Mainframe | 146 |
| 1470 | TV Test Signal Generator | 148 |
| 1474 | TV Sync Generator | 148 |
| R148 | PAL TV Test Signal Generator | 148 |
| R148-M | PAL-M Test Signal Generator | 148 |
| 1480C | TV Waveform Monitor | 142 |
| 1480R | TV Waveform Monitor | 142 |
| 1481C | TV Waveform Monitor | 142 |
| 1481R | TV Waveform Monitor | 142 |
| 1482C | TV Waveform Monitor | 142 |
| 1482R | TV Waveform Monitor | 142 |
| 1485C | TV Waveform Monitor | 142 |
| 1485R | TV Waveform Monitor | 142 |
| 1502, 1503 | TDR Cable Testers | 153 |
| 172 | Programmable Test Fixture | 396 |
| 1710B | NTSC Wvfm Monitor | 138 |
| 1711B | PAL Wvfm Monitor | 138 |
| 1740 | NTSC Wvfm/Vector Monitor | 141 |
| 1741 | PAL Wvfm/Vector Monitor | 141 |
| 1742 | PAL-M Wvfm/Vector Monitor | 141 |
| 1750 | NTSC Wvfm/Vector Monitor | 140 |
| 1751 | PAL Wvfm/Vector Monitor | 140 |
| 176 | Pulsed High Current Fixture | 397 |
| 177 | Standard Test Fixture | 398 |
| 178 | Linear IC Test Fixture | 400 |
| 1910 | Digital Generator | 145 |
| 1980 | ANSWER (Automatic Video Measurement Set) | 147 |
| 206, 206D | SCOPE-MOBILE® Carts | 423 |
| 212 | 500 kHz Dual Trace Portable Oscilloscope | 287 |
| 213 | 1 MHz Portable Oscilloscope/DMM | 285 |
| 214 | 500 kHz Dual Trace Portable Storage Oscilloscope | 292 |
| 221 | 5 MHz Portable Oscilloscope | 284 |
| 2213A | 60 MHz Dual Trace Portable Oscilloscope | 278 |
| 2215A | 60 MHz Dual Trace Portable Oscilloscope | 278 |
| 2220 | 60 MHz Single Time Base Portable Digital Storage Oscilloscope | 310 |
| 2230 | 100 MHz Dual Time Base Portable Digital Storage Oscilloscope | 310 |
| 2235 | 100 MHz Dual Trace Portable Oscilloscope | 274 |
| 2235L | 100 MHz Dual Trace Portable Oscilloscope | 274 |
| 2235 Opt 01 | 100 MHz Dual Trace Portable Oscilloscope | 274 |
| 2236 | 100 MHz Dual Trace Portable Oscilloscope | 272 |
| 2335 | 100 MHz Dual Trace Portable Oscilloscope | 268 |
| 2336 | 100 MHz Dual Trace Portable Oscilloscope | 268 |
| 2337 | 100 MHz Dual Trace Portable Oscilloscope | 268 |
| 2430 | 150 MHz Dual Trace Portable Digtal Storage Oscilloscope | 307 |
| 2445 | 150 MHz Four Channel Portable Oscilloscope | 259 |
| 2465 | 300 MHz Four Channel Portable Oscilloscope | 259 |
| 2465CTS | 300 MHz Four Channel Portable Oscilloscope | 259 |
| 2465DMS | 300 MHz Four Channel Portable Oscilloscope | 259 |
| 2465DVS | 300 MHz Four Channel Portable Oscilloscope | 259 |
| 284 | Pulse Generator | 374 |
| 305 | 5 MHz Dual Trace Portable Oscilloscope/DMM | 283 |
| 308 | Data Analyzer | 127 |
| 314 | 10 MHz Dual Trace Portable Storage Oscilloscope | 291 |
| 318 | Logic Analyzer | 124 |
| 336 | 50 MHz Dual Trace Portable Digital Storage Oscilloscope | 313 |
| 338 | Logic Analyzer | 124 |
| 390AD | Programmable Waveform Digitizer | 326 |
| 4041 | System Controller | 298 |
| 4041DDU | Disk Drive Unit | 301 |
| 4104A | Computer Display Terminal | 58 |
| 4105A | Computer Display Terminal | 58 |
| 4106A | Computer Display Terminal | 58 |
| 4107A | Computer Display Terminal | 59 |
| 4109A | Computer Display Terminal | 59 |
| 4111 | Computer Display Terminal | 62 |
| 4114B | Computer Display Terminal | 63 |
| 4114B30 | Computer Display Terminal Workstation | 63 |
| 4125 | 2D Color Graphics Workstation | 65 |
| 4125P | 2D Color Graphics Workstation | 65 |
| 4128 | 3D Color Graphics Workstation | 66 |
| 4129 | 3D Color Graphics Workstation | 66 |
| 4170 | Local Graphics Processing Unit | 61 |
| 4170S3 | Drafting System | 61 |
| 4170S4 | Drafting System | 61 |
| 4170S5 | TekniCAP Presentation System | 61 |
| 4404 | Artificial Intelligence System | 70 |
| 4405 | Artificial Intelligence System | 70 |
| 4406 | Artificial Intelligence System | 70 |
| 4510A | Rasterizer | 76 |
| 4612 | Video Hard Copy Unit | 78 |
| 4631 | Hard Copy Unit | 78 |
| 4632 | Video Hard Copy Unit | 78 |
| 4634 | Image Forming Module | 79 |

| Type | Instrument Description | Page |
|---|---|---|
| 466 | 100 MHz Portable Storage Oscilloscope | 288 |
| 4691 | Color Graphics Copier | 77 |
| 4692 | Color Graphics Copier | 76 |
| 4695 | Color Graphics Copier | 77 |
| 485, R485 | 350 MHz Dual Trace Portable Oscilloscopes | 256 |
| 492 | Spectrum Analyzer | 162 |
| 492P | Programmable GPIB Spectrum Analyzer | 162 |
| 494 | Spectrum Analyzer | 155 |
| 494P | Programmable/Spectrum Analyzer GPIB | 155 |
| 4957 | Graphic Tablet | 79 |
| 4958 | Graphic Tablet | 79 |
| 496 | Spectrum Analyzer | 161 |
| 496P | Programmable GPIB Spectrum Analyzer | 161 |
| 4991S1 | Graphic Input Workstation | 74 |
| 5A14N | 1 MHz Four Trace Amplifier | 248 |
| 5A15N | 2 MHz Amplifier | 248 |
| 5A18N | 2 MHz Dual Trace Amplifier | 248 |
| 5A19N | Differential Amplifier | 249 |
| 5A21N | Differential Amplifier/Current Probe Input | 249 |
| 5A22N | Differential Amplifier | 250 |
| 5A26 | Dual Differential Amplifier | 250 |
| 5A38 | Dual Trace Amplifier | 242 |
| 5A48 | Dual Trace Amplifier | 243 |
| 5B10N | Time Base/Amplifier | 251 |
| 5B12N | Dual Delayed Sweep Time Base | 251 |
| 5B25N | Digitizer Time Base | 329 |
| 5B40 | Time Base | 243 |
| 5B42 | Delaying Time Base | 243 |
| 5CT1N | Curve Tracer Plug-in | 252,402 |
| 5D10 | Waveform Digitizer | 247 |
| 5S14N | Dual Trace Sampling Unit | 232,252 |
| 50M10 | Programmable A/D Converter | 351 |
| 50M20 | Programmable D/A Converter | 351 |
| 50M30 | Programmable Digital Input/Output Card | 351 |
| 50M40 | Programmable Relay Scanner Card | 352 |
| 50M41 | Programmable Low-Level Scanner | 352 |
| 50M50 | Programmable Memory Card | 353 |
| 50M70 | Programmable Development Card | 353 |
| 5110 R5110 | 2 MHz Single-Beam Oscilloscopes | 244 |
| 5111A R5111A | 2 MHz Single-Beam Storage Oscilloscopes | 244 |
| 5113, R5113 | 2 MHz Dual-Beam Storage Oscilloscopes | 244 |
| 5116 | Color Storage Oscilloscope | 246 |
| R520A | TV Vectorscope | 142 |
| R521A | TV Vectorscope | 142 |
| R522A | TV Vectorscope | 142 |
| 5223, R5223 | 10 MHz Digital Storage Oscilloscopes | 328 |
| 528A | TV Waveform Monitor | 143 |
| 5440 R5440 | 50 MHz Single-Beam Oscilloscopes | 241 |
| 5441 R5441 | 50 MHz Variable Persistence Storage Oscilloscopes | 241 |
| 576 | Curve Tracer | 394 |
| 577/D1 | Storage Curve Tracer Mainframe | 398 |
| 577/D2 | Curve Tracer Mainframe | 398 |
| 606B | General Purpose Waveform Monitor | 82 |
| 608 | High Brightness Display Monitor | 82 |
| 6130 | Intelligent Graphics Workstation | 50 |
| 6130S11 | Single User Drafting System | 55 |
| 6130S12 | Two User Drafting System | 55 |
| 6130S71 | Technical Data Analysis System | 56 |
| 6130S73 | Technical Data Analysis/ Presentation System | 56 |
| 6130S62 | UNIX Software Development System | 54 |
| 620 | General Purpose Waveform Monitor | 82 |
| 634 | High Resolution Video Monitor | 82 |
| 650HR | TV Picture Monitor | 149 |
| 650HR-1 | TV Picture Monitor | 149 |
| 651HR | TV Picture Monitor | 149 |
| 651HR-1 | TV Picture Monitor | 149 |
| 652HR-1 | TV Picture Monitor | 149 |
| 655HR-1 | TV Picture Monitor | 149 |
| 656HR-1 | TV Picture Monitor | 149 |
| 7A13 | Differential Comparator Amplifier | 218 |
| 7A15A | Single Trace Amplifier | 214 |
| 7A16A | Single Trace Amplifier | 213 |
| 7A16P | Programmable Amplifier | 323,325 |
| 7A17 | Single Trace Amplifier | 214 |
| 7A18A | Dual Trace Amplifier | 215 |
| 7A19 | Single Trace Amplifier | 213 |
| 7A22 | Differential Amplifier | 219 |
| 7A24 | Dual Trace Amplifier | 215 |
| 7A26 | Dual Trace Amplifier | 215 |
| 7A29 | Dual Trace Amplifier | 213 |
| 7A42 | Logic Triggered Vertical Amplifier | 216 |
| 7B10 | Time Base | 223 |
| 7B15 | ΔDelaying Time Base | 223 |
| 7B50A | Time Base | 224 |
| 7B53A | Dual Time Base | 224 |
| 7B80 | Time Base | 220 |
| 7B85 | ΔDelaying Time Base | 220 |
| 7B87 | Time Base w/Pretrigger Acquire Clock | 220 |
| 7B90P | Programmable Time Base | 325 |
| 7B92A | Dual Time Base | 322 |
| 7CT1N | Curve Tracer Plug-in | 219,402 |
| 7D11 | Digital Delay | 226 |
| 7D12 | A/D Converter | 227 |
| 7D13A | Digital Multimeter | 225 |
| 7D15 | Universal Counter/Timer | 228 |
| 7D20, 7D20T | Programmable Digitizers | 315 |
| 7K11 | CATV Preamplifier | 167,169 |
| 7L12 | Spectrum Analyzer | 168,229 |
| 7L14 | Spectrum Analyzer | 166,229 |
| 7L5 | Spectrum Analyzer | 170,229 |
| 7M11 | Dual 50 Ω Delay Line | 235 |
| 7S11 | Sampling Unit | 234 |
| 7S12 | TDR/Sampler | 233 |
| 7S14 | Dual Trace Delayed Sweep Sampler | 232 |
| 7T11A | Sampling Sweep Unit | 234 |
| 7104, R7103 | 1 GHz Real Time Oscilloscopes | 194 |
| 7603, R7603 | 100 MHz Oscilloscopes | 201 |
| 7612D | 200 MHz Programmable Waveform Digitizer | 321 |
| 7613, R7613 | Variable Persistence Storage Oscilloscopes | 210 |
| 7623A R7623A | Multimode Storage Oscilloscopes | 208 |
| 7633 R7633 | Multimode Storage Oscilloscopes | 208 |
| 7704A | 250 MHz Oscilloscope | 199 |
| 7834 | Fast Storage Oscilloscope | 206 |
| 7844, R7844 | 400 MHz Dual-Beam Oscilloscopes | 203 |
| 7854 | 400 MHz Waveform Processing Oscilloscope | 318 |
| 7904A R7903 | 500 MHz Oscilloscope | 197 |
| | 500 MHz Oscilloscope | 197 |
| 7912AD | Programmable Transient Waveform Digitizer | 324 |
| 830L01 | Two Bank Library Pack | 150 |
| 830L02 | Four Bank Library Pack | 150 |
| 830L03 | Eight Bank Library Pack | 150 |
| 830M01 | Memory Pack | 150 |
| 830M02 | Memory Pack | 150 |
| 830M03 | Memory Pack | 150 |
| 830M04 | Memory Pack | 150 |
| 830M05 | Memory Pack | 150 |
| 830M06 | Memory Pack | 150 |
| 830M07 | Memory Pack | 150 |
| 830M08 | Memory Pack | 150 |
| 830M09 | Memory Pack | 150 |
| 830RDA | ROM Pack Development Aid | 150 |
| 830R01 | General Purpose ROM Pack | 150 |
| 830R03A | Link Test ROM Pack | 150 |
| 830R07 | PARS/IPARS ROM Pack | 150 |
| 830R10 | SDLC/SNA ROM Pack | 150 |
| 830R13 | SDLC/SNA ROM Pack | 150 |
| 834 | Programmable Data Comm Tester | 150 |
| 835 | Programmable Data Comm Tester | 150 |
| 836 | Programmable Data Comm Tester | 150 |
| 834RDA | ROM Pack Development Aid | 150 |
| 834R01 | General Purpose ROM Pack | 150 |
| 834R02A | Bisynchronous ROM Pack | 150 |
| 834R03A | Link Test ROM Pack | 150 |
| 834R04 | HDLC/X-25 ROM Pack | 150 |
| 834R05 | Extended Instruction Set ROM Pack | 150 |
| 834R06 | Bisynchronous ROM Pack | 150 |
| 834R07 | PARS/IPARS ROM Pack | 150 |
| 834R10 | SDLC/SNA ROM Pack | 150 |
| 834R11 | Extended Monitor ROM Pk | 150 |
| 834R13 | SDLC/SNA ROM Pack | 150 |
| 8540A | Microcomputer Integration Unit | 95 |
| 8550 | Microcomputer Development Lab | 91 |
| 8560 | Multiuser Microcomputer Development Lab | 91 |
| 8561 | Multiuser Software Development Unit | 91 |
| 8562 | Multiuser Development System | 91 |
| 91AE04A | Data Acquisition Module | 110 |
| 91A04A | Data Acquisition Module | 110 |
| 91A08 | Data Acquisition Module | 109 |
| 91A24 | Data Acquisition Module | 109 |
| 91AE24 | Data Acquisition Module | 109 |
| 91A32 | Data Acquisition Module | 109 |
| 91 DVV | Digital Analysis Software | 113 |
| 91P16 | Pattern Generator Module | 110 |
| 91P32 | Pattern Generator Module | 110 |
| 91S16 | Pattern Generation Module | 108 |
| 91S32 | Pattern Generation Module | 108 |
| 91HS8 | Data Acquisition Module | 107 |
| 91HSE8 | Data Acquisition Module | 107 |

# Tektronix Means . . . Measurement Capability, GPIB Compatibility

## Tektronix' Systems Experience

Long before publication of the IEEE Standard 488-1975, Tektronix had entered the test and measurement systems business. The measurement speed and capabilities of the Tektronix automated oscilloscope and Tektronix semiconductor test systems quickly highlighted the benefits to be gained from measurement automation. And just as quickly came the realization that a system interfacing standard was needed. But what standard?

The possibilities of the proposed IEEE Standard 488 were recognized. And, when the IEEE Standard 488 became reality, GPIB compatibility was already an integral part of Tektronix product planning and engineering. The result is that Tektronix is now a recognized major supplier of a full line of GPIB system components—a supplier that puts more than a decade of systems planning, design, and implementation experience into each product.

In 1978 the standard was further refined (IEEE Standard 488-1978) defining an interfacing system that has become a widely accepted instrument industry standard. The major areas it specifies are:

1. Mechanical—the interface connector and cable. See Table 1.
2. Electrical—the logic signal levels and how the signals are sent and received.
3. Functional—the tasks an instrument's interface may perform—such as sending data, receiving data, triggering the instrument, etc.—and the protocols to be used. See Table 2.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical, and functional standard. These GPIB-compatible instruments and instrument controllers make it possible to achieve the benefits of automated test systems without paying the previous price of custom system design. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or star configuration.

**TABLE 1**
**GPIB HARDWARE CHARACTERISTICS SUMMARY**

- Cable lengths up to and not exceeding 20 meters (approximately 66 feet) with a device load required for every 2 meters of cable.
- Up to 15 devices (1 controller and 14 instruments) may be connected in linear or star configurations.
- Voltages are generally TTL-compatible.
- GPIB signal and data lines are asserted (or true) when pulled low ($\leq +0.8$ V) and released (or false) when high ($\geq +2.0$ V).
- Maximum data rate of up to 250 kilobytes/second over a distance of 20 meters, with 2 meters per device, or faster with some special restrictions (refer to IEEE Standard 488-1978 for details).

**TABLE 2**
**INTERFACE FUNCTIONS**
**DEFINED BY IEEE STANDARD 488-1978**

| Function | Description |
|---|---|
| Source Handshake (SH) | Synchronizes message transmission |
| Acceptor Handshake (AH) | Synchronizes message reception |
| Talker (T) | Allows instrument to send data |
| Listener (L) | Allows instrument to receive data |
| Service Request (SR) | Requests service from controller |
| Remote-Local (RL) | Allows instrument to select between GPIB interface and front-panel programming |
| Parallel Poll (PP) | Allows up to eight instruments to simultaneously return a status bit to the controller |
| Device Clear (DC) | Puts instrument in known state |
| Device Trigger (DT) | Starts some basic operation of the instrument |
| Controller (C) | Sends device addresses and other interface messages |

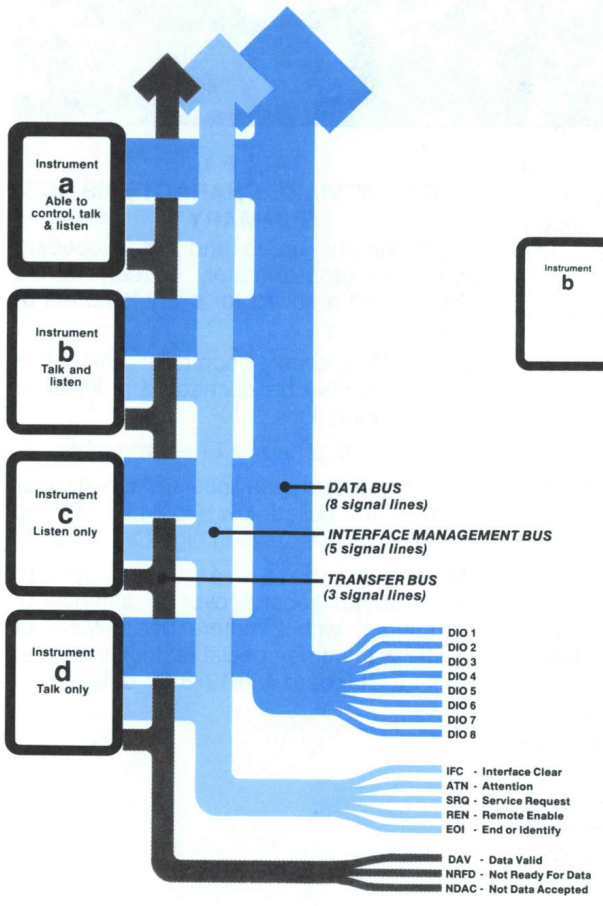
An automated test and measurement system usually consists of the following components:

- Multiple instruments: these are either *stimulus* instruments, such as function generators, pulse generators, and power supplies; or *measurement* instruments, such as counters, waveform digitizers, and multimeters.
- Controller with software: this tells the instruments what to do, collects the results, and processes them. The system controller is generally a small computer. The software or firmware operating system must have a powerful, flexible I/O structure to handle GPIB bus traffic. It must also have processing power for waveform manipulation and graphics power for display.
- Computer peripherals: these are devices such as tape drives, printers, and plotters that store or display the results of the tests.
- A keyboard: this enables the user to send commands or information to the system.
- A display: the display allows the user to review intermediate results and to monitor system operation.

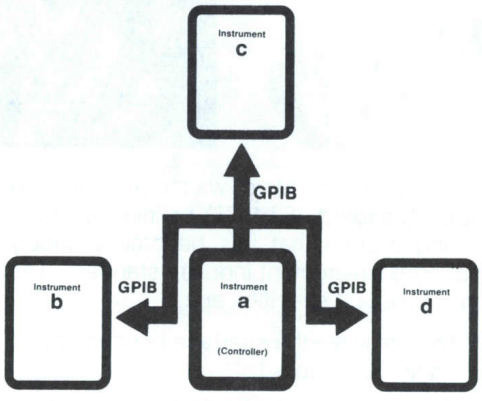
For smaller systems, one or more of these last three components are often incorporated in the system controller. Larger, more powerful systems, however, may be minicomputer-based, augmented by one or more high-speed mass storage devices, a graphic display terminal, and run under specialized instrument control and signal processing software such as TEK SPS BASIC or the 6000 Family Tek (proposed) ANSI BASIC.

All these components can be easily interconnected if the GPIB interface has been built in and appropriate functions made programmable. Before GPIB, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. With the GPIB this is no longer a requirement. Users can directly link up to 14 instruments with the controller via the bus, and set up the systems in linear or star configurations. Additionally, some controllers can drive more than one GPIB port. The Tektronix 4041 has an option for a second port, allowing control of up to 28 instruments. Or, if you need more, TEK SPS BASIC operated with a properly optioned DEC PDP-11 minicomputer can drive up to four GPIB ports, providing a total system potential of 56 instruments. The 6130 has the capability to accommodate up to seven GPIB ports for the most demanding applications.

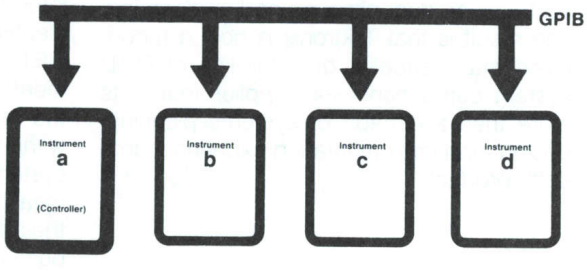
**GPIB System Components**




**Star Configuration**




**Linear Configuration**



All these devices (the controller, measurement instruments, and peripherals) comprise the hardware. The system cannot operate, however, unless it is driven by software.

There are two levels of software necessary: the operating system software and user written application programs. The operating system software provides a set of commands and functions that the user combines into a program that delineates the measurement and processing task to be performed. The software, guided by the user program, works through the controller to tell the instruments what signals to generate, what measurements to make, and tells the controller what to do with the results.

The software and the program in the controller make the system do what the user wants. The GPIB interface allows users to plug system components together, but without software, the system can do nothing.

In programmable instrument systems, the "language" of the software or program has several meanings:

1. The controller has its own language, such as BASIC or C, and users must express their intentions in this language.
2. Within the context of the controller's language, the instrument's commands (or "language") have to be sent over the GPIB.
3. The actual control of the GPIB interface is transparent to the user with Tektronix instrument controllers and software.

In order to make the system operate, the user has to:

1. Know what tasks the system is to perform—the system can do nothing by itself.
2. Know the controller's language.
3. Know the kind of data or language the instruments are designed to exchange.

To make these tasks easier for you, Tektronix has taken several steps beyond simple IEEE Standard 488-1978 compatibility. Consistency has been designed into each system component for the greatest degree of compatibility. Intelligence has been designed in to relieve you from interfacing details. And firmware and software have been designed and written to provide the maximum in programming ease and measurement capability.

## Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE Standard 488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users usually won't need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

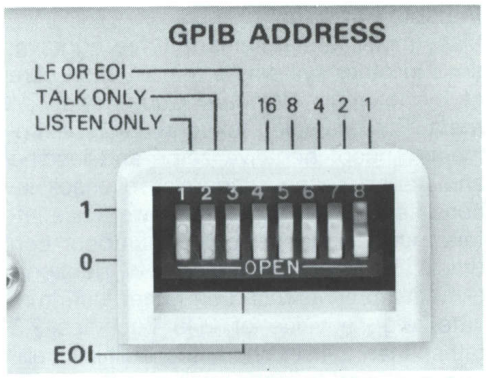
A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit. But, since the IEEE Standard 488-1978 allows several optional message terminators, Tektronix instruments go an extra step by providing a switch for selecting optional terminators. These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

The result is a line of products that are not only GPIB compatible—but are capable GPIB instruments. They have the features that make them useful and the compatibility that makes them work together.

## Tektronix *Standard Codes and Formats* Means Programming Ease

IEEE Standard 488-1978 specifies the hardware interface and its basic functional protocol. It also specifies a set of codes called interface messages that control interface functions. However, the IEEE Standard 488-1978 does not specify the syntax or coding of device-dependent messages—the messages that control the programmable features of the instrument.

Since the device-dependent messages are not specified, instruments that conform to the IEEE Standard 488-1978 may use inconvenient or even incompatible message formats. It's much like a telephone system—the hardware link is well defined, but unless both parties speak the same language, communication is impossible. That's why Tektronix developed a codes and formats standard that specifies the syntax and coding of device dependent messages, while retaining full IEEE Standard 488-1978




*Each GPIB instrument or peripheral, called a device, must be assigned a different system address; this can be done simply by setting switches, usually located on the back panel of the device.*

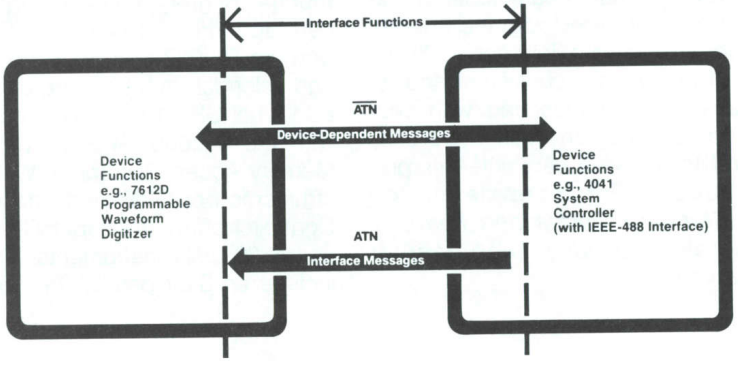
compatibility. The Tektronix *Standard Codes and Formats* specifies message coding to:

- Be simple and unambiguous.
- Use commands that are common among similar devices.
- Use simple, easy-to-remember mnemonics.

The benefits of the Tektronix *Standard Codes and Formats*, a major feature of the Tektronix GPIB communications protocol, are numerous. Because of their natural English-like structure, instrument control commands and messages are easy to use. The result is a GPIB implementation that is specifically designed to overcome the programming rigidity and cumbersome procedures of other GPIB systems.

### ASCII Data Standard

Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set the center frequency of the 492P Spectrum Analyzer to 1.75 MHz, the command is simply written FREQ 1.75 MHz—no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human readable form.



### Flexible Formats

Many minor format items that are aggravations in other systems are also taken care of by Tektronix *Standard Codes and Formats*. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper and lower case letters. And, since truncated numbers can drastically affect measurements, Tektronix GPIB instruments round off rather than truncate: e.g., a value of 2.49 becomes 2.5 rather than 2.4. In short, the built-in intelligence is used to make intelligent decisions. That makes your programming job much less rigid and substantially easier.

### Common Messages

To make things even easier, Tektronix *Standard Codes and Formats* also specifies messages that are to be common to all Tektronix programmable instruments. For example, you can program your system to learn the current settings of any Tektronix GPIB instrument by sending the instrument the SET? message. Any GPIB compatible instrument from Tektronix—whether it is a waveform digitizer, a programmable power supply, or a function generator—interprets SET? the same way. The instrument firmware gathers the instrument's settings together and assembles them into a human readable message to be sent over the bus to the controlling software. If you know how to operate a function generator, then you already know how to read a settings message from a Tektronix GPIB compatible function generator.

### BASIC Languages

Because users are increasingly interacting with GPIB systems at the controller keyboard rather than at instrument panels, GPIB systems must be as friendly as possible. This means, too, that the controller languages should be simple, logical, and easy to interpret and implement. That's why BASIC, the established language for Tektronix' instrument controllers, is the preferred language of Tektronix *Standard Codes and Formats*.

BASIC is an established language with wide use and familiarity. It is also an English-like language that is easy to learn and understand. So, combined with the English-like messages used with Tektronix GPIB instruments, it becomes a consistent and familiar means of communicating with your system. And your program listings are easy to read and follow, with very little interpretation required. (For more details on Tektronix *Standard Codes and Formats*, ask your Tektronix sales engineer or representative.)

## Controllers and Software to Match Your Needs

Tektronix offers controller-software packages to meet varying GPIB system needs.

### Controllers/Software packages:

- The 4041 System Controller, optimized for instrument control in a variety of situations, including test and measurement and spectrum analysis.
- The 6130 intelligent workstations, with 32-bit processor capabilities and excellent GPIB control.
- TEK SPS BASIC software with the DEC PDP-11 Series and DEC MICRO/PDP-11 minicomputers, optimized for systems with full waveform acquisition, processing, and graphics.

### Software Packages

- "GURU" software, an interface package for the IBM PC (or IBM-compatible PC), using National's GPIB card. This package contains a TEST PROGRAM GENERATOR, programming examples and an excellent manual to help the novice user get started or the familiar user be more productive.
- The TekMAP (Tektronix Measurement Applications Programs) library of software products supports the Tektronix 7000 Series GPIB programmable digitizers and extends their versatility by integrating them with Tektronix controllers, IBM personal computers or HP-Series 200 technical computers.

### The 4041 System Controller

The 4041 System Controller is a compact, modular controller designed for rackmount, bench-top, or portable use. Its operating system language is an extended BASIC designed for use by both the casual and the sophisticated programmer.

The 4041 controller contains three microprocessors, with the CPU being the powerful 16-bit 68000. Standard memory is 32 kilobytes with optional expansion to a maximum of 512 kilobytes. A 20-character alphanumeric LED display, a 20-character thermal printer, a DC 100 magnetic tape cartridge drive, 18 function keys, a GPIB port, an RS-232 port, and a real-time clock and calendar capability are all standard. An additional GPIB/RS-232 port pair is optional, with the second GPIB port having Direct Memory Access capability. With 14 GPIB instruments per GPIB port, the 4041 System Controller offers the capability of controlling up to 28 GPIB instruments. Other options include an 8-bit parallel TTL interface (Option 02); SCSI (Small Computer System Interface, Option 03, for external disk mass storage and a second RS-232 port) to support interfacing to floppy and hard disks for greater file and data storage; and a detachable program development/debug keyboard.

*Tektronix 4041 System Controller*

The capabilities of standard 4041 BASIC can be expanded by installing ROM (Read-Only Memory) packs to extend operational features of the 4041 into a broad range of systems applications, with functions running faster than equivalent BASIC routines.

The program development ROMs (with keyboard, or an RS-232 terminal), give the engineer or production test programmer access to the system language. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for a friendly and interactive system. A variety of other features are also included to increase friendliness. For example, viable names may be up to eight characters long, allowing meaningful names such as RISETIME, VOLTAGE1, or DELAY. And as another example, subprograms and program lines can be named—e.g., 1000 SRQPOLL: or 200 RMS VOLTS—for quick and easy access.

Beyond enhancements for simplicity, 4041 BASIC also has enhancements that make it a powerful tool for sophisticated programmers. It includes capabilities for FORTRAN-like subprograms, variable passing from main program to subprograms, declaration of local and global variables, and many other features.

Yet, for all its sophistication, the 4041 is still particularly desirable for use by lower-skill operators in a production environment. Instrument control programs can be designed and written to print user prompts on the 4041 display and the programs can be assigned to any of the ten user-definable keys on the 4041 front panel. Then the 4041 program development ROM and keyboard can be removed from the controller. This puts the 4041 into an execute-only mode with its programs protected. The lower-skill user need only follow the front-panel display prompts and press the designated keys to execute programs.

To return to the engineering or program development mode, simply plug the program development ROMs (with keyboard or an RS-232 terminal) back into the 4041. You again have access to all of the ease and power of 4041 BASIC programming.

The 4041R01 Graphics ROM pack gives the 4041 the capability to generate graphic commands to interact with peripheral devices using Tektronix compatible graphic codes. These high-level and primitive commands allow you to construct and incorporate graphic images, symbols, charts and diagrams into your system applications, greatly enhancing system usability.

The 4041R02 Plotting ROM Pack gives the 4041 the capability to generate graphs and to plot data. Designed as an easy-to-use tool to automatically generate scientific graphics, the plotting ROM pack requires the presence of the 4041R01 Graphics ROM Pack in order to operate. Graphs can be generated and displayed on any graphic peripheral device supported by the 4041R01. The automatic plotting commands are the heart of the 4041R02. These commands, given your data, draw axes with appropriate tic marks and plot the desired data. You need little experience to program graphics or plotting routines. All you need to do is supply the data to be graphed.

The 4041R03 Signal Processing ROM Pack gives the 4041 the ability to support instrumentation system applications requiring waveform processing. Coupled with our programmable digitizers and oscilloscopes, it will produce broader system configurations and effective solutions for signal analysis. The functions contained in the 4041R03 provide a high level approach to deal with signal processing applications normally solved by lengthy programs requiring extensive knowledge of waveform processing and computer fundamentals. Combined with the graphics and plotting ROM packs, the 4041R03 allows you to produce, analyze and display waveforms semiautomatically.

The 4041R04 Utility ROM Pack adds still more general purpose capabilities to your 4041. These range from such convenience items as one line descriptions of error codes to capabilities for building PROM files for programming your own EPROMS.

**6130 Intelligent Graphics Workstations**

The 6130 workstation combines state-of-the-art microprocessor technology, advanced architectures, and flexible system software. They are designed to meet a wide range of computing system applications.

**GPIB Interface**

An important 6130 feature is a standard GPIB interface that supports programmable instruments such as oscilloscopes, digitizers, audio test systems, multimeters, function generators, spectrum analyzers, and logic analyzers. As with other Tek GPIB based products, the 6130 conforms to the IEEE-488 standards and to Tektronix' own *Standard Codes and Formats* that specifies the syntax and coding of device-dependent messages.

The standard GPIB interface is capable of transferring data and messages at speeds up to 25 kilobytes per second and of supporting up to 14 GPIB-compatible instruments, in addition to the 6130 interface itself. The instruments are classified as either controllers, talkers or listeners. The controller supervises the GPIB, determining which instruments send and receive data over the bus. A talker sends messages and data over the bus, and a listener receives messages and data. The 6130 programmable interface allows the user to specify device-dependent parameters, such as primary and secondary addresses, end-of-message and end-of-header delimiters.

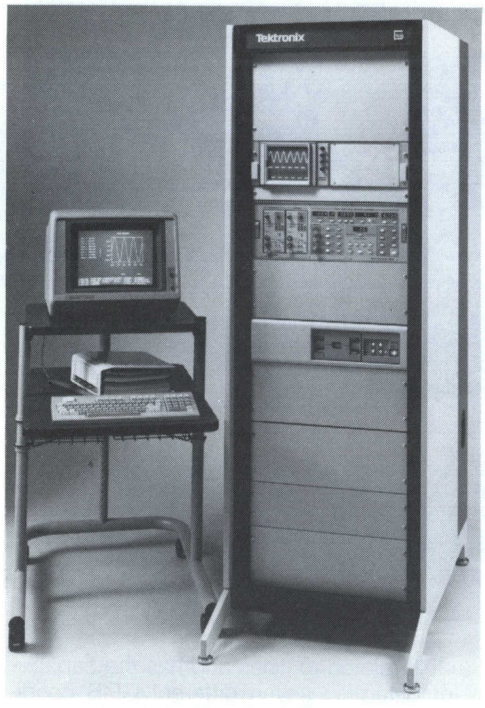
In addition to the standard GPIB, each 6130 workstation can support up to six additional high-speed GPIB ports. These high-speed ports use direct memory access (DMA) to transfer block data into a cache memory at rates up to 250 kbytes per second.

The primary language used for GPIB communication is Tek's own version of the (proposed) ANSI BASIC. This version includes 39 GPIB-related routines and has the capability of detecting seven different GPIB conditions. Because it is a compiled rather than an interpreted version, program execution is extremely quick. In addition to having all the standard features of the proposed ANSI BASIC, Tek's version adds GPIB functionality, extended I/O, array slices (which facilitates matrix manipulation), I/O enhancements, and an easy-to-use programming environment and compiler. A 4050 sifter program provides a utility for converting 4050 programs into Tek ANSI BASIC format.

Among the I/O enhancements of Tek's ANSI BASIC is the ability to handle synchronous or asynchronous communications automatically, eliminating complicated addressing and control commands. Another is the ability to perform byte level transfers while retaining full control of all GPIB conditions. Tek's ANSI BASIC can communicate with the bus itself or with any instrument on the bus.

**TEK SPS BASIC Software with DEC PDP-11 Minicomputers**

When equipped with Tektronix supplied GPIB interfaces, DEC PDP-11 Series minicomputers can be operated with TEK SPS BASIC software to provide the most powerful big-system instrument control and signal processing. A wide variety of peripherals can be handled, including plotters, line printers, graphic terminals, magnetic tapes, and single or multiple disk storage systems. Additionally, with the proper options, up to four GPIB interface ports can be supported. This means control of and data collection from up to 56 GPIB instruments.




*Tektronix MS 3201 Acquisition/Processing Measurement System using TEK SPS BASIC and a DEC PDP-11 Minicomputer.*

Two versions of TEK SPS BASIC are available, the standard version and the extended memory version. The extended memory version permits processing of very large arrays in computers having up to 128 kilowords of memory with memory management.

Other than memory differences, both versions of TEK SPS BASIC software have the same major features. These include a modular architecture consisting of a resident monitor and an expandable library of over 100 nonresident commands. This unique design lets you configure a software system to meet your specific needs yet leaves the system open for adding new commands and processing modules.

Measurement data can be stored and accessed in a variety of ways. Information can be read or written in either ASCII or binary. Named files can be accessed on hard or flexible disks, magnetic tape, or cassettes. Information can be read from files either sequentially or randomly. TEK SPS BASIC commands give you complete file management capability.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

There's also data logging capability for automated waveform capture. And the software's better than 7-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Plus, there are special data structures to retain both numeric and literal information (scale factors and units) associated with a given waveform. This waveform data structure, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Beyond extending the standard mathematical operations and functions to include waveform processing, TEK SPS BASIC also provides special waveform processing functions. Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed—all with single commands. Polar conversions can also be performed with a single command to present results such as magnitude and phase.

With its large array size capabilities (limited only by memory in most cases), advanced signal processing, and program and instrument tasking capabilities (including error control for independent operation), TEK SPS BASIC offers all of the flexibility and power necessary to control anything from the simplest to the most sophisticated test and measurement system.

### GURU Software

GURU is a simple but powerful package that provides control of GPIB (IEEE Standard 488) electronic instruments from an IBM PC (or compatible). It offers menu-driven Test Procedure Generator to speed applications programming.

GURU's Test Procedure Generator (TPG.BAS), written in BASIC, is a self-explanatory menu-driven program. It is the right tool for instrument system users who want fast results or who don't want to learn to program their system in BASIC. It allows users to generate a program that runs a specific test sequence—without writing a single line of code. Users need to know only the details of the test to be performed and the equipment used.

The TPG is most suited to non-digitizer applications where testing of devices is required using programmable power supplies, digital voltmeters, signal sources, and counters.

For users who want to write their own application programs, GURU provides SUBS.BAS, a set of canned subroutines. These subroutines perform functions common to many test and measurement applications, complementing the IBM PC compatible MICROSOFT BASICA language (an advanced form of BASIC).

### TekMAP Software

The Tektronix Measurement Application Programs (TekMAP) library of software products supports the Tektronix 7000 Series GPIB programmable digitizers in automated engineering or research environments. It extends the versatility of Tektronix digitizers by integrating them with Tektronix controllers, IBM personal computers or HP-Series 200 technical computers.

Basic communication utilities, accessible through friendly menu-driven user interfaces, are available through Communication and Control Utility Software.

Extended measurement capabilities (such as automated pulse parameter analysis, Fast Fourier transformation and propagation delay measurements) are provided by the Time and Amplitude Measurement Software products.

## Tektronix Support for Your GPIB System

With GPIB products and signal processing systems from Tektronix, you're not left on your own after the product is purchased. Tektronix offers complete support and training for the operation and maintenance of its GPIB products and systems.

Every product is shipped with a complete and comprehensive operating manual. Additionally, a variety of training services are available. Training classes are available both at our home office and at selected sites around the world.

As part of the long-term support for GPIB products and systems, Tektronix offers a variety of application literature and support.

*HANDSHAKE* is an applications newsletter from Tektronix published quarterly, and contains application and technical articles covering the broad spectrum of instrument control and signal processing.

The Tektronix Instrumentation Software Library provides software and application information for Tektronix programmable measurement instruments and systems. There are three types of software currently available: Measurement Software, Instrument Utility Software, and User-Exchange Software. The Tektronix Instrumentation Software Library catalog provides program abstracts and ordering information.

An extensive collection of application notes and magazine article reprints is another source of information offered by Tektronix. Our sales offices and sales representatives maintain a list of current literature and will be glad to supply you with items in your areas of interest.

Warranties and service are another part of the support you get from Tektronix. Tektronix maintains a network of service centers for your maintenance needs at strategic locations throughout the world.

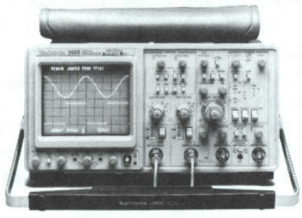
## Guide for Selecting GPIB Instruments

When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitability in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your sales representative when considering instruments to be used in GPIB configurations:

1. Is the instrument intended for interactive measurement analysis or automated measurement; i.e., are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?
2. Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level? (For example, AH1 is needed for any useful interaction, SH1 is required for instruments supplying measurements to the controller.)
3. Are diagnostics available to check out the instrument from the front panel or over the GPIB interface?
4. Does the instrument use standard codes and formats conventions for terminators, numeric formats, etc.?
5. Can the instrument's front-panel setting be read from the controller and saved for later automated set up?
6. Can the front panel be "locked out" via the GPIB?

## DATA ACQUISITION PROGRAMMABLE OSCILLOSCOPES



**2465/2445 Option 10, 2465 CTS/DMS/DVS Programmable Oscilloscopes*1*2**

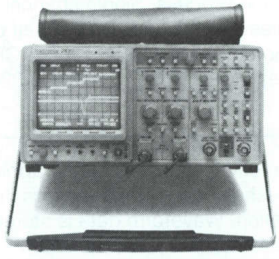
300 MHz/150 MHz Bandwidth at Probe Tip

Delta Volts/Delta Time Cursors

Optional: Counter, Timer, Trigger/DMM, Word Recognizer, Video Measurements

Measurement Results of CRT Readout Available Over the Bus

2465/2445 oscilloscopes can be easily programmed to assist the scope operator in performing a complete sequence of measurements. Front panel settings can be remotely set or changed with display prompting of messages, providing guidance for the operator. The results of voltage, time, frequency, phase, and ratio can be both displayed on the CRT and read back over the bus. The 2465 CTS is ideal for automatic frequency, period, pulse width and time between events measurements; the 2465 DMS for automatic test and measurements; and the 2465 DVS for high resolution video applications. See page 257.



***NEW* 2430 Digital Storage Oscilloscope**

150 MHz Bandwidth

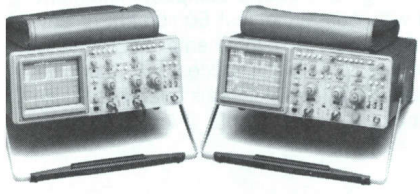
Save on Delta

100 MS/s Sample Rate

2 ns Glitch Capture

The *NEW* 2430 brings the best features of our industry standard 2400 Series into the digital world. It features 150 MHz bandwidth, dual channel simultaneous acquisition, 5 ns maximum sweep speed, 8-bit vertical resolution. The new Tek-patented feature, "Save-on-Delta", makes pass/fail decisions. The 2430 is fully programmable over the GPIB. It sends and receives waveforms, front panel settings, custom menus, and operator prompts. Outputs include an analog plotter output. It is compatible with the P6407 Word Recognizer probe. See page 308.

## WAVEFORM ACQUISITION PRODUCTS



***NEW* 2230/2220 Digital Storage Oscilloscopes**

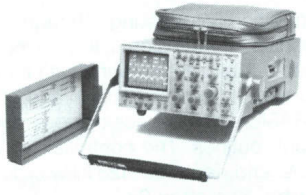
100 MHz/60 MHz Bandwidth

4 k Record Length

Time and Voltage Measurement Cursors (2230)

Save Reference Memory

These portable, high-value oscilloscopes feature both digital storage and nonstorage capability to 100 MHz (2230) and 60 MHz (2220). 100 ns glitch capture is accomplished with the Peak Detect mode (envelope), which digitizes and stores, in acquisition memory as a data pair, the minimum and maximum levels of the input signal. The 2230 and 2220 also feature unlimited storage time; expandable, compressible, repositionable stored traces; save reference memory; pre-/posttrigger viewing; roll and scan modes; standard X-Y plotter output; and optional interfaces. See page 310.



**336 Option 01 Digital Storage Oscilloscope**

140 kHz Storage Bandwidth

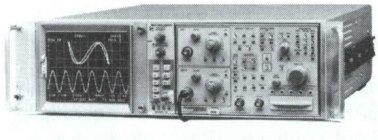
Time and Voltage Measurement Cursors

50 MHz Nonstorage Bandwidth

CRT Readout, Only 5 kgs (11 lbs)

Signal Averaging

This compact oscilloscope can simultaneously display analog and digital waveforms, and can store up to 16 digitized waveforms for recall and display. Vertical and horizontal scale factors, delay time position, and voltage and time readouts of cursor positions are displayed on the CRT, as is a menu of many of the features and modes. An Auto mode for both vertical volts/division and horizontal time/division allows "hands-off" operation in many applications. See page 311.



**7D20/7D20T Programmable Digitizers*1*2**

70 MHz Equivalent Time Bandwidth

40 MHz Sample Rate

8-Bit Vertical Resolution

Pretrigger and Posttrigger

Simultaneous Acquisition on 2 Channels

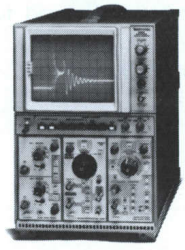
The 7D20 plug-in converts any 7000 Series mainframe into fully programmable, digital oscilloscopes. Operating modes include: Envelope, Average, and Roll. Optimized for interactive and automated applications, from biomedical research to radio modulation. Remotely controllable over the GPIB. Shown with R7603 mainframe.

The 7D20T provides the same digitizer capabilities in a compact stand-alone package. Supported by TekMAP 7D20 Time and Amplitude Measurement software. See page 315.

**1 Remotely controllable.*
**2 Fully programmable.*

# TEK IEEE STANDARD 488 COMPATIBLE SYSTEM INSTRUMENTS

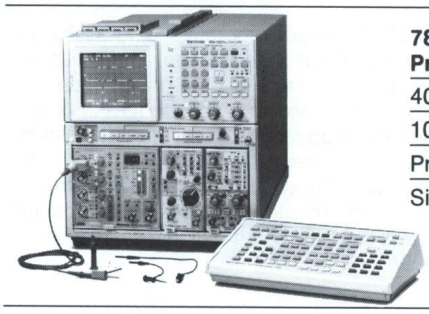
## WAVEFORM ACQUISITION PRODUCTS



### 5223 Option 10 Digitizing Oscilloscope*1

- 10 MHz Equivalent Time Bandwidth
- 1 MHz Sample Rate
- 10-Bit Vertical Resolution
- Pretrigger and Bi-Slope Triggering
- X-Y Analog Plotter Output
- Roll and Vector Modes

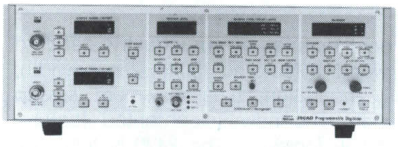
This 10 MHz digital storage oscilloscope provides a digitized display that will never fade or bloom. Selecting Roll mode yields a continually updated display of memory contents by providing a strip-chart-like view of signals at slow sweep rates. Applications range from measuring mechanical displacement transducer signals to biomedical activities. Option 10 GPIB Interface provides I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through this interface for either BINARY or ASCII. Plug-in functions not remotely controllable. See page 328.



### 7854 Waveform Processing Oscilloscope*1

- 400 MHz Equivalent Time Bandwidth
- 10-Bit Vertical Resolution
- Pretrigger and Posttrigger
- Signal Averaging

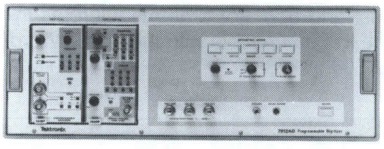
A two-channel, waveform processing, digital storage oscilloscope. Keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines for tests or experiments. Signal averaging capability can recover signals buried in noise and improve measurement accuracy. All mainframe keystroke functions and operating modes can be remotely controlled via the GPIB. (Plug-in functions controllable only with custom interface. Contact your local sales engineer.) Supported by TekMAP 7854/IBM PC Communication software. See page 318.



### 390AD Programmable Digitizer*1*2

- Cursor-Based Measurements
- Sample-Rate Switching
- Direct Plotter Output Capability

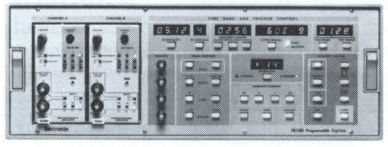
This two-channel, 10-bit digitizer achieves excellent dynamic accuracy with a two-stage flash-conversion process. Single-channel operation can provide 60 megasamples per second. Built-in self-calibration and self-test features. Remotely controllable over the GPIB. Applications vary from ultrasonic testing to video. See page 326.



### 7912AD Programmable Digitizer*1*2

- 100 GHz Equivalent Sampling Rate
- 500 ps/div Calibrated Sweep Rate
- 500 MHz Bandwidth at 10 mV/div
- Built-in Signal Averaging

The 7912AD is designed for interactive and automated applications. It digitizes and stores singleshot or repetitive signals from millisecond to subnanosecond duration. Waveform data is stored in a 4096 word memory. See page 324.



### 7612D Programmable Digitizer*1*2

- 200 MHz Dual Channel Sampling
- Dual Time Base, Sample-Rate Switching
- Variable Record Lengths to 2048 Words Each Channel
- 8-Bit Vertical Resolution
- Pretrigger and Posttrigger

Two independent waveform digitizers in one compact instrument, the 7612D is ideal for use with Automatic Test Equipment or anywhere highly accurate, time-domain measurements are required. Memory partitioning helps capture fast, successive, randomly occuring events. Multiple sample rate switching is available during waveform acquisition. Remotely controllable over GPIB. See page 321.

## CONTROLLER-BASED ACQUISITION/PROCESSING MEASUREMENT SYSTEMS

### MS 3101

- Acquisition to 200 MHz w/Program Control
- Acquisition to 1 GHz via Direct Access Plug-in
- Program and Data Storage on Disk
- Waveform and Array Processing
- 100 GHz Equivalent Sampling Rate
- High Resolution Color Graphic Display

The MS 3101 is a complete acquisition, processing, storage, and display system for high-speed signals and transients. It is based on the Tektronix 7912AD Programmable Digitizer operating with a controller, a Tektronix 4105A Color Graphics Display Terminal and other peripheral equipment. TEK SPS BASIC software includes operational packages and system checkout routines. The controller will accommodate four GPIB Interfaces and features 128 kilowords of memory and floating-point hardware. See page 337.

### MS 3201

- Acquisition to 80 MHz w/Program Control
- Sampling Rates to 200 MS/s
- Waveform and Array Processing
- Real Time GPIB Instrument Control
- Two Independent Digitizing Channels
- High Resolution Color Graphic Display

The MS 3201 is a complete acquisition, processing, and storage system for high-speed signals and transients. It is based on the 7612D Programmable Digitizer operating with a controller, a Tektronix 4105A Color Graphics Display Terminal and other peripheral equipment. TEK SPS BASIC Software includes operational packages and system checkout software. The controller will accommodate four GPIB Interfaces and features 128 kilo words of memory and floating-point hardware. See page 337.

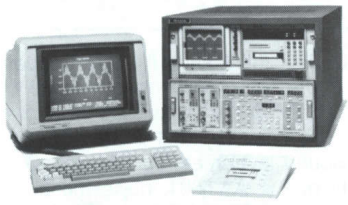
*1 *Remotely controllable.*
*2 *Fully programmable.*

## DESKTOP CONTROLLER-BASED ACQUISITION/PROCESSING MEASUREMENT PACKAGES

**MP 2501**

Extended Waveform Processing
Mag Tape Program and Data Storage
High Resolution Color Graphic Display
GPIB Instrument Control

Based on the Tektronix 7854 Oscilloscope and the 4105A Color Graphics Display Terminal/4041 System Controller equipped with ROM packs, this system can acquire, process, store, and display electrical signals. 4041 BASIC routines from the Utility Software permit system operation with limited programming experience. The 7854 is remotely controllable over the GPIB. See page 334.



**MP 2101**

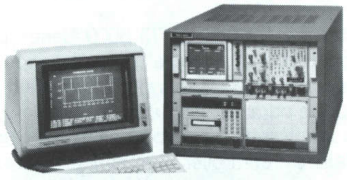
Acquisition to 200 MHz w/Program Control, 1 GHz w/Direct Access Plug-In
100 GHz Equivalent Sampling Rate
Waveform Processing
High Resolution Color Graphic Display

Based on the Tektronix 7912AD Programmable Digitizer, the MP 2101 is a high-speed, signal acquisition and transient digitizing system. The 7912AD is remotely controllable over the GPIB. Utilizes the 4041. See page 333.

**MP 2201**

Acquisition to 80 MHz w/Program Control
Two Independent Digitizing Channels
Sampling Rates to 200 MS/s
Waveform Processing
High Resolution Color Graphics Display

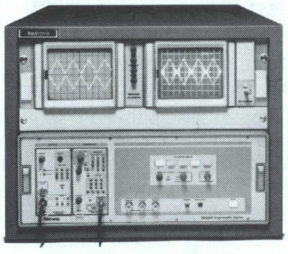
Based on the Tektronix 7612D Programmable Digitizer, the MP 2201 is a complete signal acquisition, waveform processing, storage, and display system. The 7612D is remotely controllable over the GPIB. Utilizes the 4041. See page 333.



**MP 2401**

Two Channel Acquisition up to 70 MHz
Ideal for Rugged Environments
GPIB Instrument Control
Waveform Processing
High Resolution Color Graphics Display

Based on the 7D20T Programmable Digitizer, the MP 2401 provides an ideal general purpose signal analysis configuration. Packages dual-channel configuration with enveloping, averaging, cursor measurements, and comparison to prestored waveforms. Utilizes the 4041. See page 333.



**MP 1101**

Ultra High Speed Single-Shot Digital Storage Capability
Nine-Bit Vertical Resolution

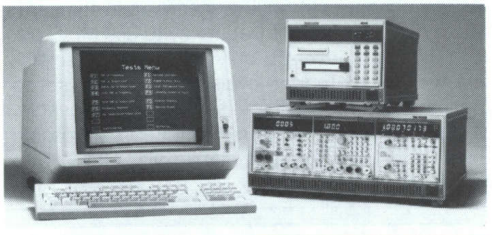
Based on the Tektronix 7912AD Programmable Digitizer. This compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller. See page 332.

**MP 1201**

200 Megasamples/Second Maximum Rate, Each Channel
Multi-Records/Channel (up to 2048 Words Cumulative Total)

Based on the Tektronix 7612D Programmable Digitizer. This compatible signal acquisition and display package can be front-panel controlled or completely programmed via the GPIB Interface from any suitable controller. See page 332.

## AUDIO MEASUREMENTS PACKAGE

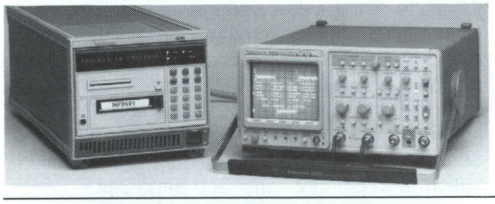


***NEW*** **MP 2902**

Test Program Generation by Nonprogrammers
Rapid, Error-Free Test Program Generation
Supports Custom Test Requirements
State-of-the-Art Performance

The Audio Test Program Generation software allows rapid development of an automated audio measurement system, even by nonprogrammers. Tests supported include: total harmonic distortion vs frequency, total harmonic distortion vs output level, intermodulation distortion vs level (SMPTE & CCIF), CCIF intermodulation distortion vs frequency, frequency response, signal-to-noise, level (voltage and power), linearity, external stimulus, and others. See page 335.

## OSCILLOSCOPE MEASUREMENT PACKAGES



***NEW*** **MP 2601**

Two Channels Simultaneous Acquisition
150 MHz Bandwidth for Repetitive Signals
Ease of Use via Menu-Driven Control
2430 Oscilloscope

The MP2903 couples the 4041 Controller and 2430 Oscilloscope. This portable measurement package provides extensive signal acquisition capabilities with signal analysis to form a system directed at measurement solutions. See page 334.

***NEW*** **MP 2903**

Test Program Generation by Nonprogrammers
Error-Free Test Program Generation
2465DVS Oscilloscope
Counter/Timer/Word Recognizer

The MP2903 couples TEK EZ-TEST program development software with the 2465DVS programmable oscilloscope. With the software development time dramatically reduced by TEK EZ-TEST and the flexible measurement performance of the 2465DVS oscilloscope, achieving the cost savings and quality improvement of automation is within easy reach. See page 336.

# TEK IEEE STANDARD 488 COMPATIBLE SYSTEM INSTRUMENTS

## INCOMING INSPECTION TEST STATION

**MP 2901**

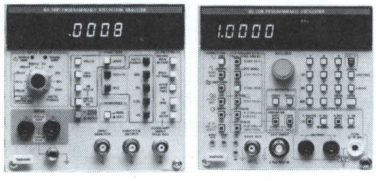
Flexible, Modular TM5000 Instrumentation

TEK EZ-TEST Software

Rapid, Error-Free Software Development

The MP2901 addresses two of the most difficult aspects of automating an operation-software development and interfacing to the device-under-test. The multifunction interface (MI5010) allows easy data acquisition and/or control of the device-under-test by the 4041 System Controller. The task of software development is made rapid and easy. TEK EZ-TEST leads nonprogrammers (via a set of menus) to translate manual procedures into error-free, structured BASIC code. See page 335.

## GENERAL PURPOSE INSTRUMENTS

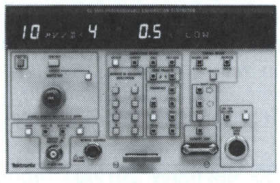


**AA 5001/SG 5010**
**Programmable Audio Test System*[1]**

Fast, Accurate, Repeatable Measurements

Automatic, Low-Cost Documentation of Test Results

Automatically performs such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal for dynamic headroom tests. See page 348.



**CG 5001**
**Programmable Calibration Generator*[1]**

Tests Oscilloscope Current and Voltage Accuracy to ±0.25%

Tests Markers and Slewed-Edge Timing Accuracy to ±0.01%

Verifies Scope Probe Accuracy

A microprocessor-based TM 5000 Series plug-in designed to be an integral part of a controller-based system for calibrating and verifying major oscilloscope parameters. Learn mode allows front panel control settings to be assimilated as program data by controller. All front panel settings are remotely controllable via the GPIB. Contains built-in self test routine. See page 385.

**DC 5009**
**Programmable Universal Counter/Timer*[1]**

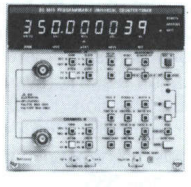
Frequency and Period to 135 MHz

Auto Trigger, Averaging, Self Test

10 ns Clock, Ratio Architecture

Trigger Level and Shaped Outputs

This dual-channel, microprocessor-based TM 5000 Series plug-in provides frequency and period measurement to 135 MHz and features push-button automatic trigger-level setting and eight measurement functions. An arming input permits measurement of selected events within complex waveforms. Option 01 provides an oven-controlled 10 MHz crystal oscillator. All front panel settings and features are remotely controllable over the GPIB. See page 342.



**DC 5010**
**Programmable Universal Counter/Timer*[1]**

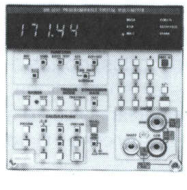
Dc to 350 MHz

Auto Trigger, Auto Averaging

3.125 ns Clock, Ratio Architecture

Arming Input and Shaped Outputs

A dual-channel TM 5000 Series plug-in that provides measurement of frequency to 350 MHz, period, ratio, and event B during A, using a reciprocal technique. Trigger levels automatically set to optimum. Trigger voltage setting is displayable. Automatic self-test feature. Remotely controllable over and fully programmable via GPIB. See page 340.



**DM 5010**
**Programmable Digital Multimeter*[1]**

4.5 Digit, 0.015% Accuracy

Automatic Self Test, Math Functions

In-Circuit Resistance Measurements

Autoranging

This remotely controllable, TM 5000 Series plug-in measures dc and true RMS ac voltages and resistance. A diode-test function tests semiconductor junctions while a low voltage/ohms function allows in-circuit measurements without turning on diode or transistor junctions. Math functions include: Averaging (up to 19,999 readings), dB (ref to 1 mW or to user-supplied constant). Comparison (user-supplied upper/lower limits). Offset and Scaling (user supplied constants), or any combination of these functions. See page 344.

**FG 5010**
**Programmable Function Generator*[1]**

0.002 Hz to 20 MHz ±0.1%

20 mV to 20 V p-p from 50 Ohms

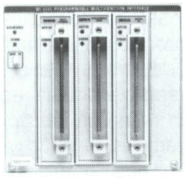
AM, FM, and VCF Modes

Auto Scan Phase Lock

This TM 5000 plug-in outputs Sine, Square and Triangle waveforms. Pulses and Ramps are provided with variable symmetry in 1% steps. Phase-lock mode automatically locks to any input signal, 20 Hz to 20 MHz. Dc offset voltage is programmable from 20 mV to 7.5 V. Can store ten front panel setups to reduce programming time. Fully programmable via GPIB. See page 346.

*[1] *Remotely controllable.*

## GENERAL PURPOSE INSTRUMENTS



**MI 5010**
**Programmable Multifunction Interface*1**

User Development Card

16 Relay Scanner, 10 Low Level Relay Scanner

16-Bit and 16 kb Digital I/O

12-Bit D/A and A/D Converter

This TM 5000 Series plug-in interface module accommodates three front-panel plug-in cards. The MX 5010 Multifunction Interface Extender provides space for three additional cards. A total of six function cards can be remotely controlled via the GPIB. Each of the seven types of function cards includes its own ROM and specific function-related firmware. See page 350.

**PS 5004**
**Programmable Precision Power Supply*1**

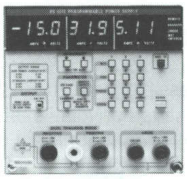
0 V to 20 V Floating Output

0.5 mV/0.1 mA Resolution

Constant Voltage or Constant Current with Autocrossover

Voltage and/or Current Monitoring Display

This TM 5000 Series plug-in provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 V to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±0.5 mV resolution without the necessity of changing ranges. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV. See page 347.



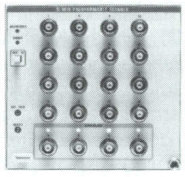
**PS 5010**
**Programmable Triple Power Supply*1**

Triple Output, Triple Display

Programmable Voltage and Current Limit

Front/Rear Outputs, Remote Sense

This TM 5000 plug-in provides three concurrent outputs; two floating at 0 V to +32 V and 0 V to −32 V dc and a logic level supply at 4.5 V to 5.5 V dc. Operation includes auto-crossover with bus interrupt on continuous-voltage or continuous-current mode change. All three supplies may be remotely controlled over the GPIB while front panel settings are locked out. Overall accuracy is ±(0.5% + 20 mV). See page 348.



**SI 5010 Programmable RF Scanner*1**

Software Configurable

Sixteen 50-Ohm Signal Channels

Real Time Clock, 350 MHz Bandwidth

Stores 80 to 300 Commands

This TM 5000 Series plug-in uses 16 RF reed relays to interconnect 20 front-panel BNC connectors in three possible combinations; four groups of four channels, two groups of eight, or one group of 16. Risetime for groups of four channels is approximately one nanosecond. Used for scanning and channel switching, this device is remotely controllable over the GPIB. See page 354.

## LOGIC ANALYZERS

**DAS 9100 Series Digital Analysis System*1**

Up to 104 Channels of Data Acquisition

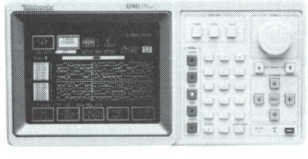
Acquisition Speeds to 2 GHz (500 ps)

Up to 192 Channels of Pattern Generation at 50 MHz

Color CRT Enhanced User Interface

Easy-to-Use Menu-Driven Interface

A general purpose, configurable, and user-upgradable digital analysis system. Available with black and white display (9109 Option 06 mainframe), without display (9119 ATE mainframe) or with color display (9129 Option 06 mainframe). All of the functions that can be accessed from the DAS 9100 Series keyboard may be controlled via GPIB. The I/O Option 06 supports GPIB data rates up to 200 kbytes per second as well as RS-232, serial line printers, hard copy units and master/slave operation. For list of Data Acquisition and Pattern Generation Modules, accessories and probes see page 103.



**1240/*NEW* 1241 Logic Analyzer**

Up to 72 Acquisition Channels

Acquisition Speeds to 100 MHz Async, 50 MHz Sync

Dual Time Base Acquisition and Display

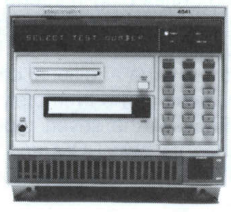
Simple Menu Operation with On-Screen Soft Keys

The 1240/1241 support all aspects of the design task, including hardware analysis, software analysis, and integration. For hardware analysis, they offer up to 36 channels of 100 MHz acquisition with 6 ns glitch detection. Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous. A flexible clocking scheme includes data demultiplexing on each acquisition probe. Acquisition, triggering and display of two independent time bases are tied together, so you can fully monitor the interaction between hardware and software. See page 114.

*1 *Remotely controllable.*

# TEK IEEE STANDARD 488 COMPATIBLE SYSTEM INSTRUMENTS

## SYSTEM CONTROLLERS



**4041 System Controller**

16-Bit CPU Based on 68000

32 k RAM, Expandable to 512 k

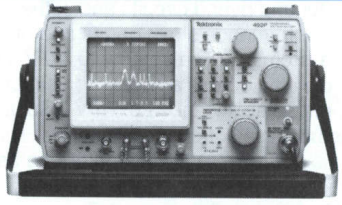
48-File Mag Tape Drive

Full Duplex, Asynchronous, RS-232 Interface

Modular Design, Rackmount or Portable

A powerful and expandable, systems controller intended principally for execute-only environments such as production-line testing. Operating parameters include Interrupt and Error Handling modes. Options and peripherals equip it for interactive flexibility in research lab applications. Programming language is BASIC with English-like commands, extensions, simple syntax, and line-by-line interpreter. A 1.8 lines/second thermal printer is built-in. See page 298.

## SPECTRUM ANALYZERS



**492P Programmable Spectrum Analyzer*[1]**

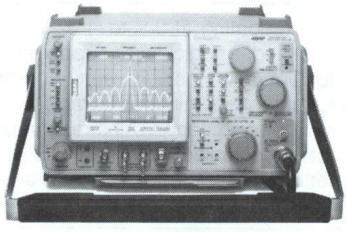
Digital Storage and Signal Processing

80 dB Dynamic Range

Amplitude Comparison in 0.25 dB Steps

100 Hz Resolution Bandwidth

A portable, 50 kHz to 220 GHz, lab quality analyzer that provides CRT readout of all important front panel settings and is fully calibrated in amplitude and frequency. Front panel adjustments can be remotely controlled over the GPIB for automated spectrum analysis via GPIB. Features microprocessor-aided, three-knob operation and flicker-free display even at the slowest sweep speeds. See page 162.



**494P Programmable Spectrum Analyzer*[1]**

Microwave Frequency Counter

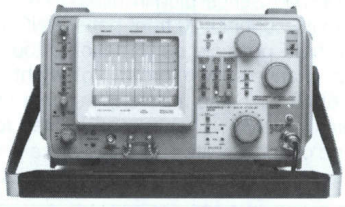
Nonvolatile Memory

Synthesizer Tuning Accuracy

30 Hz Resolution Bandwidth

HELP Manual in ROM

This 10 kHz to 325 GHz portable spectrum analyzer provides lab precision measurement capability in hostile field environments. Full control of the front panel, waveform processing, and storages are accessible via the GPIB. Features keypad data entry, nonvolatile storage of nine CRT displays and ten instrument set-ups, direct plot capability and a built-in 325 GHz frequency counter. See page 155.



**496P Programmable Spectrum Analyzer*[1]**

Digital Storage and Signal Processing

1 kHz to 1800 MHz Input Frequency

80 dB Dynamic Range

Amplitude Comparison in 0.25 dB Steps

30 Hz Resolution Bandwidth

Providing a CRT display of all important control settings, this 1800 MHz analyzer features microprocessor-aided, three-knob operation and automatic mode selection. Unit is fully calibrated in frequency and amplitude. Front panel settings can be remotely controlled. Digital storage eliminates time consuming display adjustments. See page 159.

## INTELLIGENT GRAPHICS WORKSTATIONS

**6130 Graphics Workstation**

UTek Operating System

FORTRAN, C, Pascal, ANSI BASIC

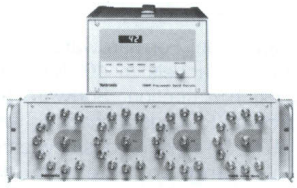
Compatible with 4100 Series Displays

General Purpose Application Software

LAN, GPIB, RS232, SCSI Interfaces

The 6130 combines the power of the 32016 microprocessor and the UTek operating system with a wide variety of utilities, languages and application programs. Both standard GPIB and optional high-speed DMA GPIB interfaces are supported as well as RS232, Sync/Async (RS422) serial interfaces. IEEE 802.3 Ethernet with TCP/IP protocol is standard. It is compatible with a wide range of Unix application programs and utilities including software development, document preparation and spreadsheets.

## PERIPHERALS FOR IEEE STANDARD 488 SYSTEMS



**1360P/1360S**
**Programmable Signal Multiplexer*[1]**

3 ms Maximum Switching Time

Dc to 250 MHz Bandwidth (1 Switch)

Input Levels up to 250 V dc or 250 mA

Expandability up to 4 Switch Modules

A microprocessor-based, programmable, system instrument that can be used to multiplex electrical signals. Switch matrix includes four identical, nine-pole coaxial switches. Operational modes determined by adjustable straps. Switch modes are: individual gangs of 1, 2, or 4. Multiples of eight inputs can be multiplexed to one output. See page 355.

*[1] *Remotely controllable.*

### RECOMMENDED GPIB CABLES

| Part Number | Description | Part Number | Description |
|---|---|---|---|
| 012-1015-00 | 0.5 meter, single shield | 012-0991-00 | 2 meters, double shield, low EMI |
| 012-0991-01 | 1 meter, double shield, low EMI | 012-0991-02 | 4 meters, double shield, low EMI |

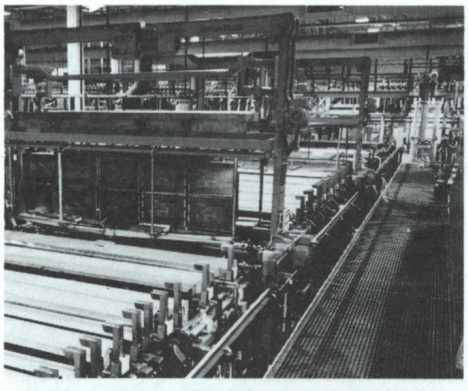
## SOFTWARE SUMMARY

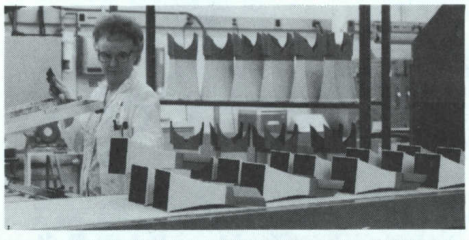
| APPLICATION | FUNCTION/PRODUCT | LANGUAGE | RUNS ON/WITH | PAGE |
|---|---|---|---|---|
| Artificial Intelligence Systems | R & D applications in expert systems, natural languages, intelligent robotics, auto programming | Smalltalk-80 LISP option<br>Prolog option | 4400 AI System | 72 |
| CAD conversion of existing drawings | Produces lines, arcs, text, symbols, & layers for insertion into popular CAD systems | FORTRAN IV | 4991S1 Workstation | 74 |
| CAD | PLOT 10<br>TekniCAD<br>TCS (Terminal Control System)<br>GKS (Graphical Kernel System)<br>IGL (Interactive Graphics Library) | <br><br>FORTRAN/object<br>FORTRAN '77<br>FORTRAN/object | <br><br>4100 Series<br>6130 Family<br>Workstations<br>DEC VAX w/VMS | 68 |
| CAE Systems<br>Design & analyze Complex electronic Circuits | Designers WorkSystem | | TekStation AT, Apollo work stations, Digital's VAX family, 6130 Workstation | 47 |
| VLSI verification and analysis | Gate Array WorkStation | | | 48 |
| Full custom chip design | Full Custom WorkSystem | | | 48 |
| Structured Custom Chip design | Structured Custom WorkSystem | | | 48 |
| Standard Cell design | Standard Cell WorkSystem | | | 49 |
| Printed Circuit Board Design | PCB WorkSystem | | | 49 |
| Compares real/prototype hardware | Test & Measurement WorkSystem | | | 49 |
| Development & Debug of Microprocessor Code | Software Development WorkSystem | | | 49 |
| Scientific Data Analysis | | Proposed ANSI Basic<br>Optional: C, 150 PASCAL, Enhanced FORTRAN 77 | 6130 Workstation | 45 |
| Engineering Data Analysis/CAE | | Optional: Proposed ANSI Basic, C, 150 PASCAL, Enhanced FORTRAN 77 | 6130 Workstation | 45 |
| Structured Analysis (SA) Tools | Graphically specifies system conceptual requirements | | 856X, VAX/UNIX, VAX/VMS | 89 |
| Structured Design (SD) Tools | Graphically specifies design requirements | | 856X, VAX/UNIX, VAX/VMS | 89 |
| Language Editors | C & Pascal Oriented Editors | | 856X, VAX/UNIX, VAX/VMS | 91 |
| Cross Assemblers | Develop code for all major microprocessors | | 856X, VAX/UNIX, VAX/VMS, & IBM PC | 91 |
| Cross C Compilers | C Compilers for major microprocessors | | 856X, VAX/UNIX, VAX/VMS & IBM PC | 91 |
| Cross Pascal Compilers | Pascal Compilers for major microprocessors | | 856X, VAX/UNIX, VAX/VMS & IBM PC | 91 |
| Emulation Systems | Real Time Emulation for all major μps | | 856X, VAX/UNIX, VAX/VMS & IBM PC | 94 |
| Trigger Trace Analyzers | Captures real time software & hardware events | | 856X, VAX/UNIX, VAX/VMS | 91 |
| High-Level Debug | Debug code at the C/Pascal source level | | 856X, VAX/UNIX, VAX/VMS | 91 |
| LANDS–Language Development Systems | Full C/Pascal Development Systems | | 856X, VAX/UNIX, VAX/VMS | 91 |

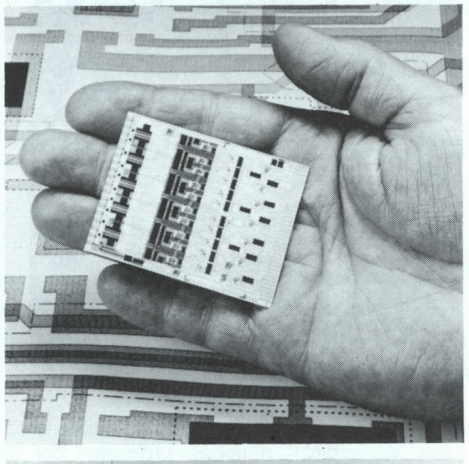
## SOFTWARE SUMMARY

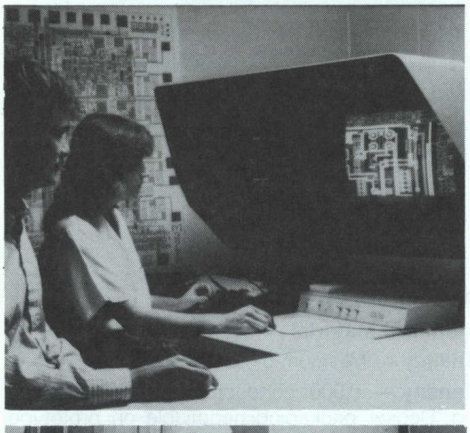
| APPLICATION | FUNCTION/PRODUCT | LANGUAGE | RUNS ON/WITH | PAGE |
|---|---|---|---|---|
| Logic Analysis<br>VLSI Verification Software Package | Links DAS 9100 to host for device verification | | VAX 7000 Series/UNIX, VMX & IBM PC | 113 |
| Performance Analysis<br>Mnemonic Disassemblers | Characterizes system performance<br>Disassembles data acquired from microprocessor-based system | | 1240/1241<br>DAS 9100<br>1240/1241 | 117<br>123<br>122 |
| Semiconductor Testing<br>VLSI<br>LSI | <br>TEKTEST V<br>TEKTEST | <br>RSX-11M based | <br>S-3295 Test System<br>S-3220 Test System | <br>134<br>135 |
| Automatic Video Measurement | Unattended monitoring of NTSC and/or PAL video signals | TEK ANSWER BASIC | 1980 ANSWER System | 147 |
| Spectrum Analysis<br>RF<br>Microwave<br>Millimeterwave | General Test:<br>Measurements<br>Filter Tests<br>Signal Search<br>Waveform Operation<br>Utilities<br>Remote Access | TEK 4041 BASIC<br>HP BASIC 3.0<br>IBM Advanced BASIC 2.1 | 490P Spectrum Analyzers/Tek 4041<br>HP9826, 9836<br>IBM PC/AT | 158 |
| Measurement Software<br>Communication Utilities | TekMAP:<br>S42P101—7854/IBM PC Communication and Control (COMMUTE) | IBM Compiled BASIC | IBM PC/XT/AT | 318 |
| Pulse Parameter Analysis | S42H201—7D20/HP Series 200 Time and Amplitude Measurement Software<br><br>067-7732-00 7D20/Tek 4041 Time and Amplitude Measurement Software | HP-BASIC<br><br>4041 BASIC | HP-216, 226, 236, or 236C<br><br>and 4105 Terminal<br>Tek 4041 and | 315 |
| Measurement Systems | Languages for Instrument Control, Signal Acquisition, Waveform Processing & Graphics | SPS BASIC<br>4041 BASIC | Micro/PDP-11<br>4041 | 330-337 |
| Single-Shot Acquisition to 500 MHz BW | MS 3101—Waveform Acquisition, Signal Analysis Support for 7912AD | SPS BASIC | Micro/PDP-11 with 7912AD | 337 |
| Single-Shot Acquisition to a 200 MHz Sample Rate | MS 3201—Waveform Acquisition, Signal Analysis Support for 7612D | SPS BASIC | Micro/PDP-11 with 7612D | 337 |
| Single-Shot Acquisition to 500 MHz BW | MP 2101—Waveform Acquisition, Signal Analysis Support for 7912AD | 4041 BASIC | 4041 Instrument Controller with 7912AD | 332 |
| Single-Shot Acquisition to a 200 MHz Sample Rate | MP 2201—Waveform Acquisition, Signal Analysis Support for 7612AD | 4041 BASIC | 4041 Instrument Controller with 7612D | 332 |
| Single-Shot Acquisition to a 40 MHz Sample Rate and to a 70 MHz BW for Repetitive Signals | MP 2401—Waveform Acquisition, Signal Analysis Support for 7D20 | 4041 BASIC | 4041 Instrument Controller with 7D20 | 332 |
| Acquisition to 14 GHz BW with Sampling Plug-Ins for Repetitive Signals | MP 2501—Waveform Acquisition, Signal Analysis Support for 7854 including Sampling Applications & TDR | 4041 BASIC | 4041 Instrument Controller with 7854 | 334 |
| Single-Shot Acquisition to 100 MHz Sample Rate and for Repetitive Signals to 150 MHz BW | MP 2601—Portable Measurement Package providing Waveform Acquisition, Signal Analysis for 2430 | 4041 BASIC | 4041 Instrument Controller with 2430 | 334 |
| General-Purpose Instrument Test Development Tool | Tek EZ-TEST | 4041 BASIC | 4041 Instrument Controller | 304 |
| Audio Test Development Tool | Tek Audio TPG | 4041 BASIC | 4041 Instrument Controller | 348 |
| GPIB Instrumentation Interface | GURU | | IBM PC (or PC compatible) | 305 |

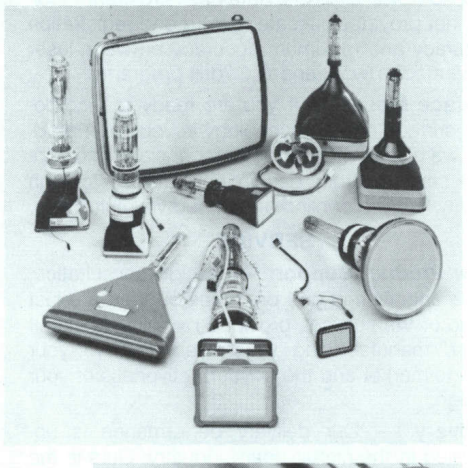
# CUSTOM COMPONENTS DESIGN & PRODUCTION SERVICES

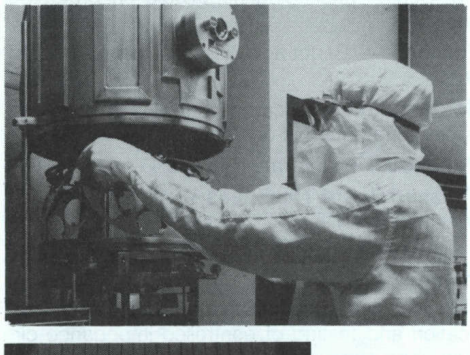


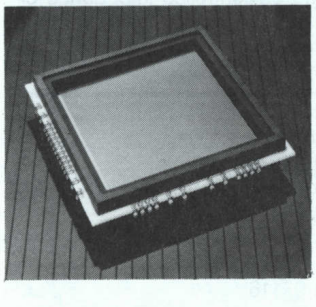


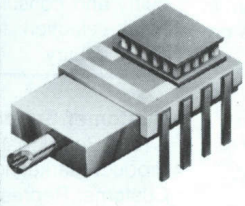


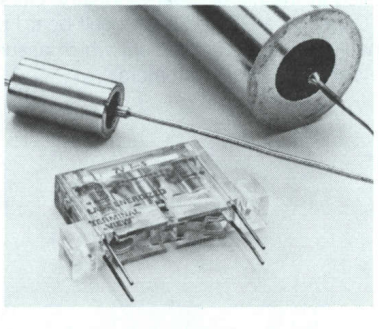












## CONTENTS


**Design & Fabrication**

Circuit Boards ..... 28
Flexible Circuits ..... 29
Plastic Products ..... 30
Metal Products ..... 31
Integrated Circuits ..... 32
Hybrid Components ..... 34
Cathode Ray Tubes ..... 37

**Components**

Laser Diode ..... 35
Coils ..... 36
Toroids ..... 36
Transformers ..... 36
Capacitors ..... 36
Magnetic Latch Relay ..... 36
Avionics CRT ..... 37
LCS Professional Color Graphics System ... 38


**Tek's world class facilities and know-how at your disposal.**

We know that your systems can only be as reliable as the components that go into them. For that reason we place a premium on dependability. We produce products that will keep you and your customers satisfied and your service costs down.

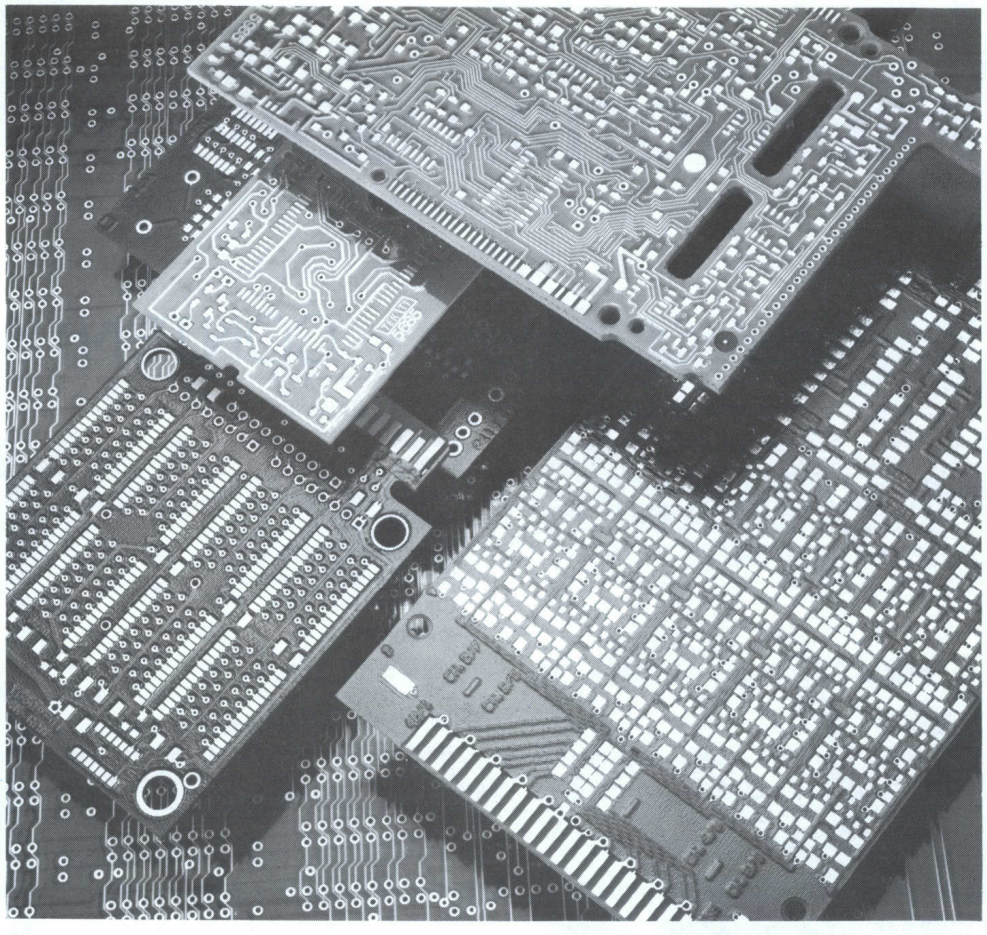
We take your design (or assist you with design) and take the entire process through manufacturing and shipment. Quality control is assured, along with on-time delivery and customer satisfaction. We want to work with you and value you as our customer.

**Tek's special application components now available for use in your latest product design.**

Now you can increase the productivity of your design team by specifying custom components designed and manufactured by Tektronix. We've made them to our exacting specifications and quality standards. You can depend on it. Contact one of our plants directly.

**Design, Manufacture, Test, Ship . . . We do it all!**

# TEK CIRCUIT BOARD MANUFACTURING



**Advanced Technology**

**Quality Service**

Tektronix circuit board manufacturing offers you a competitive advantage in bringing your high-technology products to market and keeping them there.

## TECHNOLOGY

**High Quality Multilayers** — We specialize in high quality multilayers backed by a Tektronix warranty.

**Fine-Line Circuits** — Our tight tolerances and precise registration accuracy provide high quality fine-line circuits with track widths of 0.006" and greater.

**Blind and Buried Vias** — These interconnecting vias conserve circuit board real estate by allowing only necessary layers to be connected, which frees space on other layers to be used for circuitry.

**Hot-Air Leveling** — Our state-of-the-art horizontal hot-air leveling system eliminates process variability and ensures component solderability.

**Laser Film Generation** — We use customer supplied CAD and N.C. data bases to create tooling that provides ultimate feature and registration accuracy and maximum accuracy between laser generated artwork and N.C. drill programs.

**Surface Mount** — If you are ready to incorporate surface mount technology in your next product, we offer a wide range of technology and support services from design consultation to high quality fine-line or blind and buried via multilayers.

## SERVICE

**New Product Support** — Design consultation, value engineering and prototype support are just some of the services provided by Tekronix circuit board manufacturing which can improve your time-to-market and the cost-effectiveness of your design.

**Delivery** — Our delivery performance is unequaled in the circuit board industry. Ours is the first Class "A" MRP certified circuit board plant in the world, an accomplishment which assures on-time delivery to our customers.

## CAPABILITIES

**Number of Layers** — Two to ten plus

**Standard Material** — FR-4, CEM-3

**Drilling** — Minimum 0.0135"

**Density** — 0.006" conductor width, 0.006" spacing. Denser packaging negotiable on prototype basis.

**Finishes** — Bright-acid tin, gold, hot-air leveled solder.

**Soldermasks** — Screen printed, thermal-cured epoxy, photographic dry film.

**Panel Size** — Maximum 18" x 24".

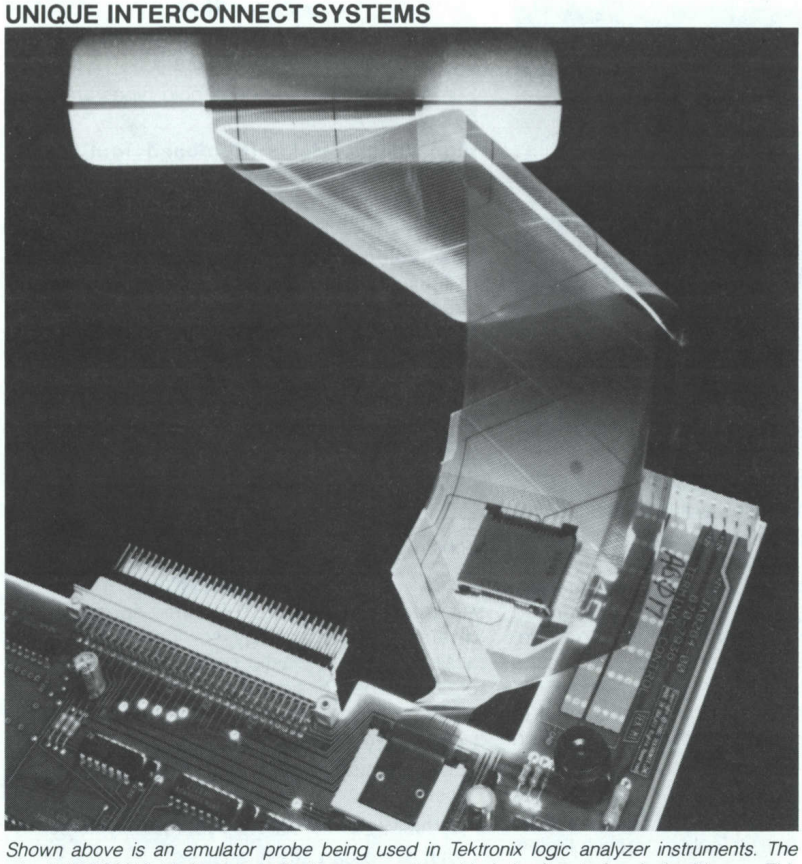
**Finished Board Thickness** — Maximum 0.125". Minimum 0.025".

**Tooling** — Computer aided/laser generated film.

**Testing and Analysis** — Complete in-house electrical, metallurgical and chemical testing. Fabrication and testing of controlled impedance circuitry and consultation in proper layups and material selection for tightly-toleranced 50 Ω and 75 Ω circuitry.

**Customer Support**
Circuit Board Manufacturing
Product Marketing Manager or
Customer Representative
Tektronix, Inc.
1521 Poplar Lane, D.S. F1-487
Forest Grove, OR 97116
(503) 640-2288

## UNIQUE INTERCONNECT SYSTEMS



*Shown above is an emulator probe being used in Tektronix logic analyzer instruments. The circuit (PM 202) folds back onto itself, making a two-sided circuit out of a single-side one. This design allows SMDs to be added directly onto the probe.*

**Pliable**

**Versatile**

**Saves Space & Weight**

### Flexible Circuits

Flexible circuits are answering needs in ways never imaginable with wire and cable technology. Generally, flexible circuits are much like printed wiring boards. (PWBs), in that their basic function is to route electrical signals, but this is where the similarity ends! Because flex ciruits are pliable (that is, flexible) they are amazingly versatile. This versatility, plus new shielding materials and extreme circuit densities fit flex circuitry for applications that can't be solved with traditional cables and printed wiring boards.

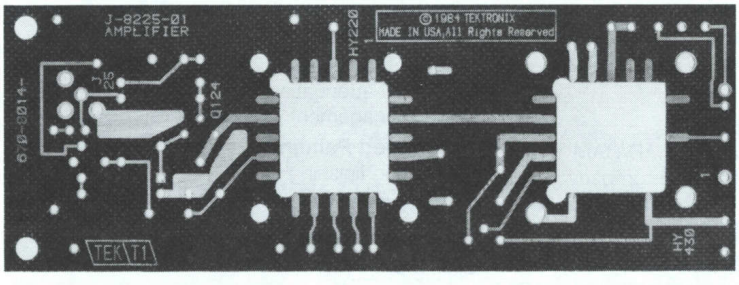
A flexible interconnect is a composite of a metal conductor and a dielectric substrate bonded together by an adhesive. These interconnects can be freely formed without cracking the metal conductor. Flexible interconnects are used to provide an electrical connection between two termination points while saving space and weight. The circuit may serve as a hinge, demanding up to millions of cycles of flexibility.

Mounting SMDs directly on etched circuitry on copper-clad polymide is gaining in popularity due to space and weight savings.

#### TYPICAL SPECIFICATIONS

**Front to back registration —** ±0.0005".
**Smallest line width and spacing —** 0.004"
**Kapton cover sheet registered to circuit pattern —** ±0.004"

**Customer Support**
Tektronix, Inc.
P.O. Box 500, D.S. 16-157
Beaverton, OR 97077
(503) 627-5314




**Low Dielectric Constant**

**Dimensional Stability**

**Close Tolerances**

### TEFLON CIRCUIT BOARDS

The utilization of higher frequencies (>10 GHz) in the field of communications and data transmission along with analytical requirements of the test instrumentation for such equipment has accented the need for accurately tuned transmission lines on circuit boards. The low dielectric constant, dimensional stability and close tolerances of raw material make Teflon an attractive selection for circuit board material in these applications.

Circuit elements of precise size and position can be fabricated for this application on glass reinforced Teflon substrates.

Certified by UL for recognized printed wiring board components. Flammability classification 94v-0. We offer complete facilities including:

- Graphic Tooling
- CAD-CAE N.C. Tooling
- Metallurgical Analysis
- Chemical Analysis and Control
- Electrolytic and Electroless Plating

All critical processes are done in a Clean Room environment.

Our routine production processes are:

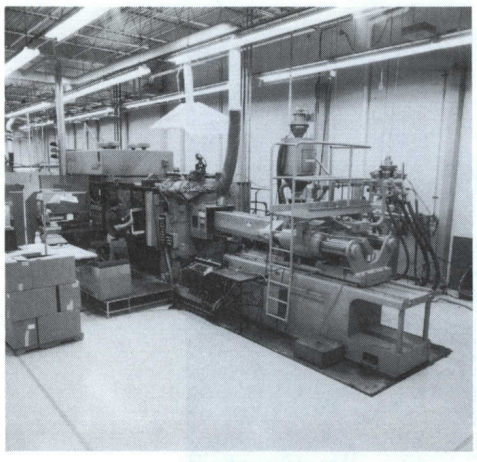
- Through Hole Plated Teflon Substrates
- Laminated Multilayers registered to ±0.004"
- Linewidths and spacing to ±0.004"
- Linewidth tolerance to ±0.0005"
- Front to back registration to ±0.0005"

#### TYPICAL SPECIFICATIONS

**Operating frequencies —** >10 GHz.
**Dielectric constant —** from 2.17 to 10.6.
**Standard dielectric thickness —** 0.005" to 0.062"; other thicknesses available.

**Customer Support**
Tektronix, Inc.
P.O. Box 500, D.S. 16-157
Beaverton, OR 97077
(503) 627-5314

# TEK PLASTIC PRODUCTS



**Design Consultation**

**Prototyping and Mold-Making**

**Manufacturing**

**Customer Support**

Tektronix Plastic Products (TPP) provides engineering services and high-quality components to enable high technology manufacturers to reduce the labor content, number of components, and cost of their products, in order to be competitive in worldwide markets.

Full-service capabilities support product design, mold design, prototyping, mold-building, and a complete range of manufacturing capabilities to meet the needs of high technology industries.

State-of-the-art injection molding technology uses thermoplastic resins, and employs multiple finishing and assembly technologies to produce a product of the highest value in terms of price, performance, and reliability.

## PROTOTYPING AND ADHESIVES CONSULTATION

Prototyping from models to polyurethane and epoxy components using silicone rubber molds.

Development assistance with jigs, fixtures, masks and protectors using silicone rubber and polyurethane. A typical application might be component masking for application of nickel-loaded acrylic paint for EMI/RFI shielding.

Selection of adhesives and solvents for bonding operations.

## CAPABILITIES

**Tool Design —** TPP uses a full 3D mechanical design package (DDN) plus a graphics applications programming language (GRAPL) for design creation, analysis, and N.C. programming of injection molds. All designs are stored in an integrated data base, which provides easy access to all design data when changing or modifying existing mold designs, or when creating new mold designs. Mold flow analysis programs enable us to help you optimize part design for the required manufacturing process.

**Electronic Data Exchange —** Tektronix has IGES in/out capability for utilizing CAD-generated data from most systems. (Tooling process time is shortened if your data base is supplied in an electronic format.) We are connected to the Tek Engineering Network, allowing us access to most engineering departments via local area networks (LAN) or Hyperchannel. We can transfer data via phone modem or 1600/6250 BPI mag tape.

**Numerically-Controlled Machining —** Tektronix has the capability to machine virtually any part or mold cavity configuration including complex shapes and contoured surfaces. By utilizing our CAD data base, considerable savings are realized in N.C. programming time. Data is transmitted from the CAD system to the machining centers via DNC (Direct Numerical Control) or punched tape.

## EQUIPMENT

TPP has three fully interactive CAD/CAM terminals linked via dedicated line to a company mainframe. We also have a C-size plotter, an N.C. tape punch, and DNC hardware.

## EXPANSION PLANS

TPP intends to maintain a state-of-the-art CAD/CAM development level. We will add additional graphics display terminals and plotting equipment as required.

## MOLD TYPES

Molds meet standard DME specifications for any custom design you may require.

Some of the more frequent mold types are listed below.

**High Volume Molds (Hardened Tool Steels) —** Built to produce in excess of 1 million quality parts. We meet or exceed all Society of Plastic Industry mold classification guidelines.

**Low Volume Molds (Aluminum) —** Primarily built for short runs. Sizes range from 1 in. round to structural foam molds 32 in. x 40 in.

**Prototype Molds, Prototype Model Lab —** Prototype tooling and model-making capabilities to aid in the development of our customers' products.

**Carrier Systems —** 3 in. x 4 in., 6 in. x 8 in., and 2 in. x 4 in. round carriers are available. Carrier systems are designed for quick setups, short runs, and cost savings on mold components and mold construction.

## SPECIAL SERVICES

As a part of Tektronix, TPP offers specially-coordinated high technology services not normally available from a plastic parts manufacturer. We provide expert design and materials consultation plus processing capability in the following areas:

**Laboratory Testing**
- EMC attenuation of conductive or coated plastic systems.
- Corrosivity of flame-retardant resin systems.
- As-molded part stress analysis.
- Surface analysis (scanning electron microscopy).
- U.L. approved molder C2160

**Plastic-Metal Combinations**
- Product enclosures.
- Functional devices.
- Outsert/insert molding operations.

**Electroless and Electrolytic Plating**
- EMC/RFI attenuation.
- Electrostatic discharge management.
- Corrosion-resistant finishing.
- Aesthetic finishing.

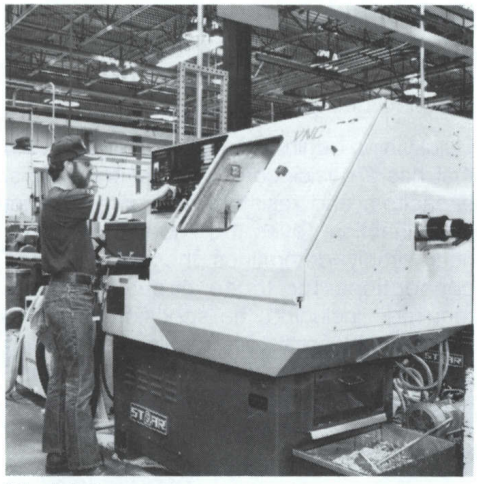
**Conductive Paint**
- EMC/RFI attenuation.
- ESD management.

**Automated Painting**
- Aesthetic finishing.

**Customer Support**

Plastic Products
Tektronix, Inc.
3000 Lewis and Clark Highway, D.S. 08-545
Vancouver, WA 98661
(206) 699-7391

CAD/CAM



Machining

Sheet Metal

# Metal Products

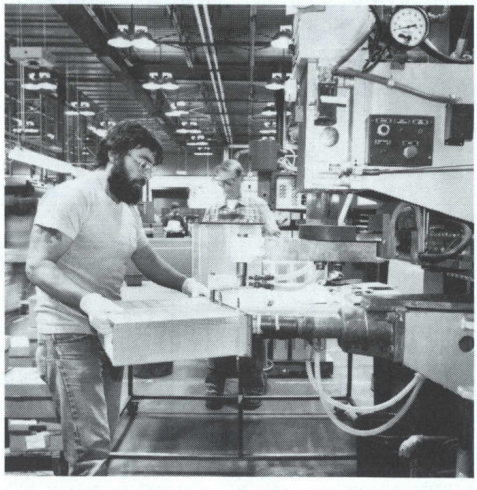
**Tool and Design**

**Manufacturing**

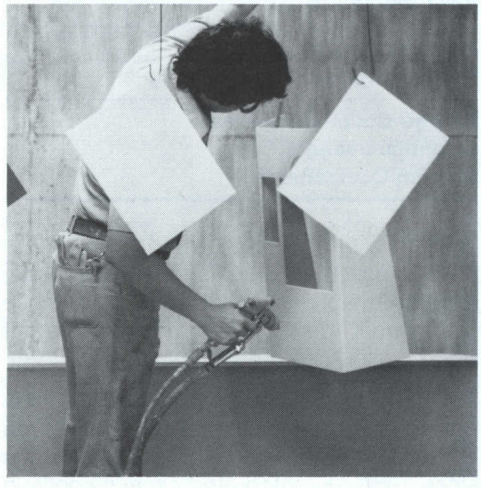
**Quality Control**

**Packaging/Shipping**

Tektronix offers complete metal products capabilities from Tool and Design through manufacturing. Quality control is assured & products shipped to customer satisfaction.



Assembly



Finishing

## MANUFACTURING CAPABILITIES

**Tool and Design** — Full design and documentation capabilities, with a tool room equipped to build and maintain most types of tooling.

**Machining** — Screw machines, sawing, and CNC milling with machine-aligned cellular processes.

**Sheet Metal** — Sanding, blank, pierce, turret punching, shearing, forming, grinding and buffing. Material types include aluminum, copper alloys, brass, and stainless steel.

**Programming** — Full programming capabilities for sheet metal and machining.

**Hardware Assembly** — Riveting, hardware insertion, spotwelding, gluing and complete enclosure assemblies.

**Finishing** — Auto and hand paint; lab for color matching. Etch, lacquer, chromate, silk screening, and printing with full nomenclature capabilities.

**Packaging and Shipping** — All items packaged and shipped to customer satisfaction.

**Quality Control** — Fully equipped with latest state of the art equipment and technology.

## EQUIPMENT LIST

**Quality Control** — Programmable measuring system by Brown & Sharpe (0.00025 obtainable measurements)

**Programming** — MEG 131 Graphic Terminals coupled to VAX 11/780 system.

**Production Machining**
- CNC screw machines
- CNC milling machines—horizontal/vertical
- CNC bar and chucker
- Automatic screw machines
- Belt sanders
- Vibratory finishers
- NC drillers
- Grinders
- Saws

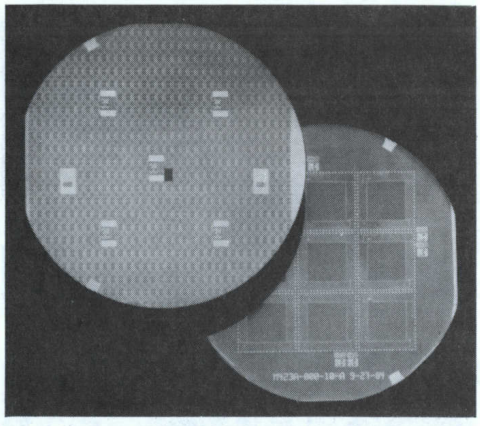
**Sheet Metal**
- Shears
- Punch presses, 0-300 ton
- Power brakes, 12-55 ton, automatic back gauges
- Spotwelders, 30 KVA-250 KVA
- Heli-arc welders

**Hardware Assembly**
- Presses, 2-8 ton
- Auto-press nut machines
- Eyelet machines
- Riveters
- Insertion machines
- Cabinet latch machines

**Finishing**
- Chromate coat, to MIL-C-5541 (clear & yellow)
- Automated etch line
- Ultra-sonic clean
- Variety chemical baths
- Automated electrostatic paint line (*Ransberg* Disc)
- Automatic silk screen machines
- Automatic printing press

**Tool/Die**
- Jig bore
- EDM
- Grinding
- Lathes, mills and drills

**Customer Support**
Metal Products
Tektronix, Inc.
P.O. Box 500, D.S. 16-157
Beaverton, OR 97077
(503) 627-5314



**Bipolar Foundry Services:**
**6.5 GHz Bipolar Analog Processes**
**QuickCustom® ICs**
**Full Custom ICs**

**Microlithography:**
**Mask Design & Fabrication**

**Charge-Coupled Devices:**
**Scientific Imagers**
**Custom Components**

Tektronix Integrated Circuits Operation (ICO) is now marketing its formidable IC design and fabrication capabilities to those who have IC performance requirements but limited resources of their own.

Tek ICO has been supplying ICs with high performance, superior quality, and proven reliability to Tektronix' product divisions since 1967. Our integrated circuits continue to provide important technological and market advantages for many state-of-the-art products. Our foundry services for analog application-specific designs are now available. In addition, a limited number of specialty components for high-performance applications are being offered on a contract basis.

Since we've developed advanced imagers for high-resolution scientific imaging and high-speed signal processing, we can supply you with custom charge coupled devices (CCDs) for these applications. The development of Tektronix high performance components required development of very sophisticated microlithography, high resolution, fine quality, VLSI mask-making services which are also available.

## BIPOLAR ANALOG INTEGRATED CIRCUITS

Two design methods are used for manufacturing custom analog ICs: "QuickCustom" and full custom.

### QuickCustom®

The short cut design approach, "QuickCustom"® helps reduce your development time and cost. It consists of a series of "QuickChip" design formats and easy-to-understand, time-saving design tools. This abbreviated design method is becoming very popular with first-time IC designers and seasoned IC design engineers.

QuickChips begin with a prefabricated chip that has a basic "core" array of transistors, capacitors and resistors configured for interconnection. Given this impetus, the engineer simply determines the custom interconnections for those circuit elements required—including the specification of laser-trimmable resistors for precise analog applications. Once final designs are determined and approved, finished wafers can be delivered (typically) within three weeks or less.

This "designer-friendly" approach was developed by Tektronix engineers who have many years of analog expertise in IC design. Their mastery of integrated analog circuit design and demonstrated experience have streamlined the design process. Today, ICO engineers are ready to provide you with as much or as little assistance as you require. The "tools" include a complete guide enabling the first-time user to complete a design with minimal one-on-one coaching. Rather than a bag full of kit parts, we provide you with a library of SPICE models for the "core" IC that will predict the performance of your design, and ensure that your QuickCustom circuit works the first time.

We also include a grid-based layout system that specifies precisely where the custom interconnects can be routed, and QuickKic, a graphic layout editor that makes it easy for even the first-time designer to digitize the layout.

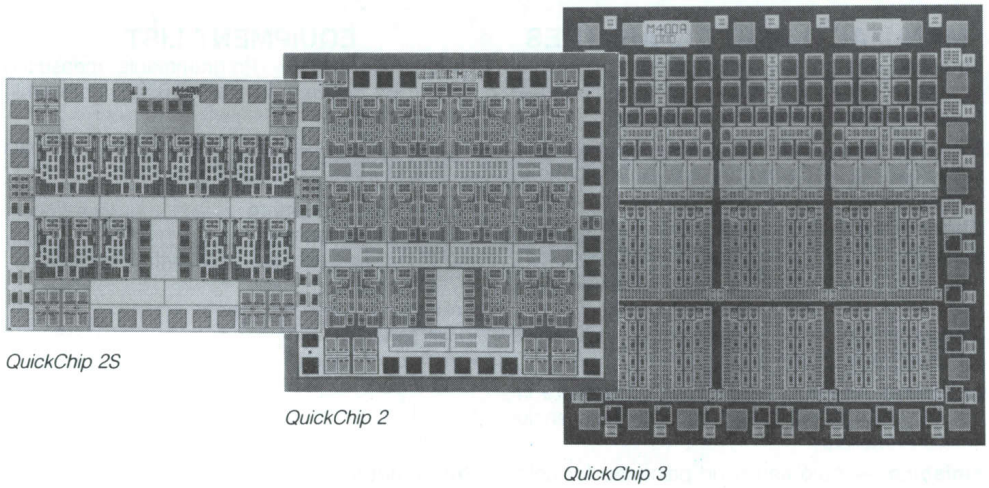
Typical ICO-developed QuickChips are shown in the adjacent photographs (QuickChips 2, 2s and 3).

## THE QuickChip FAMILY

| | NPNs*1 | $f_T$ | Max $V_{CC}$ to $V_{EE}$ | Resistors | Capacitors | Chip Size | Bonding Pads |
|---|---|---|---|---|---|---|---|
| QuickChip 1 | 18 | 6.5 GHz | 27 V | 13 Implanted Thin Film, 10 or 50 Ω/sq*2 | N/A | 1.35 mm x 1.35 mm | 13 |
| QuickChip 2 | 214 | 6.5 GHz | 27 V | 946 Implanted Thin Film, 10 or 50 Ω/sq*2 | ≤20 pF | 2.49 mm x 2.49 mm | 36 |
| QuickChip2S | 142 | 6.5 GHz | 27 V | 602 Implanted Thin Film, 10 or 50 Ω/sq*2 | ≤20 pF | 1.98 mm x 2.49 mm | 24 |
| QuickChip 3 | 168 | 2.4 GHz | 95 V | 684 Implanted Thin film, 50 Ω/sq*2 | ≤16 pF | 2.97 mm x 3.05 mm | 28 |

*1 *PNP transistors are also included in QuickChips2, 2S and 3. The $f_T$ of PNPs is approximately 30 MHz and the PNPs are optimized for use as current sources (i.e., low collector capacitance).*

*2 *Laser trimmable.*



*QuickChip 2S*

*QuickChip 2*

*QuickChip 3*

### Full Custom

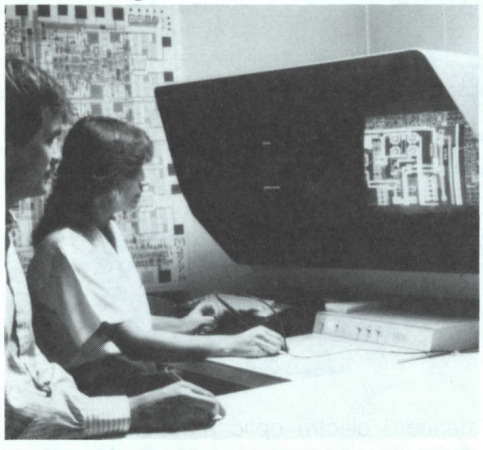
If higher performance or lower cost per chip are your requirements, ICO also offers a total custom design approach. One of our experienced applications engineers will be assigned to work with you or your team throughout the entire project. Tektronix-developed CAD/CAE software will be used to assist you through circuit analysis, simulation via SPICE, and layout, greatly improving your confidence in meeting design specifications the first time. Because we are sensitive to your proprietary needs, this engineer will be the only one with access to the technical information. Typical delivery of finished wafers is less than eight weeks from approval of design layout.

NEW

CUSTOM COMPONENT DESIGN & PRODUCTION SERVICES

## MICROLITHOGRAPHY PRODUCTS AND DESIGN SERVICES

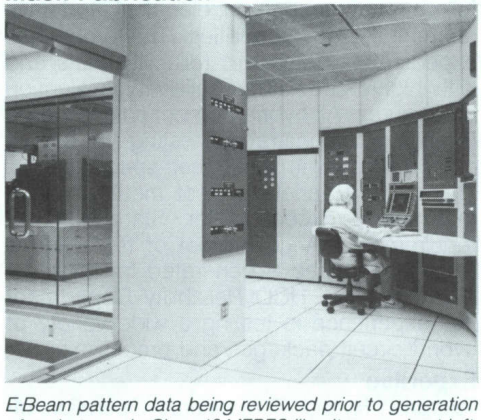
### Mask Design



*Mask design on a graphic workstation.*

From minimally supported system time to full device design, our microlithography facilities are structured to meet your mask design needs. Working from menu-based design technology and grid-based layouts, we provide QuickChip and gate array designs plus full custom, application-specific analog and digital ICs. We use mask design tools to support development of non-standard products. Routine efforts include designs for: thick- and thin-film hybrid circuits, multi-layer ceramic parts, waveguides, precision mesh components, liquid crystal and electroluminescent panels, graticules, and small chemical milled parts. Also, we are used to accommodating unusual requirements; we can handle yours.

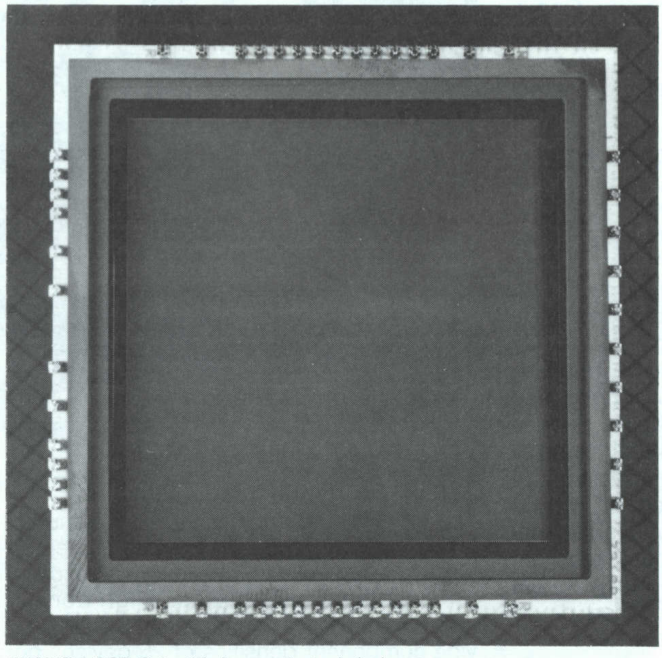
### Mask Fabrication



*E-Beam pattern data being reviewed prior to generation of a photomask. Class 10 MEBES III write room is at left.*

The same commitment to customers needs is evident in our support of mask tooling. Our state-of-the-art facility can meet all of your photomask needs. Class 10 clean room conditions are constantly maintained in critical manufacturing areas. Our technicians demonstrate the expertise and versatility to support the wide variety of work our Mask Design group creates—from 10X reticles to 1X VLSI wafer scale integration masks. This part of our facility includes both G.C.A./D.W. Mann optical systems and Perkin-Elmer Electron-Beam equipment. Our staff will work with you on an individual basis to determine which design approach will meet your requirements, and still be economical.

Our present capability provides tooling from 2½ by 2½ inch up to 7 by 7 inch glass substrates with a variety of thicknesses. We supply critical feature control from millimeter to submicron sizes, with position accuracy as small as 0.125 microns. Our claim of high quality products is backed by equipment such as Leitz MPV-DC and Nikon MPA-2A measurement systems. A Nikon CM-6 overlay comparator, Quantronix repair station, and KLA and Cambridge mask inspection systems, ensure that we deliver a superior product on time—every time.



*TK2048M CCD Scientific Imager (actual size).*

## CHARGE-COUPLED DEVICES

Charge-coupled devices (CCDs) are MOS integrated circuits that are essentially sampled data, analog delay lines. Used in such diverse applications as ultra-sensitive imaging detectors, transversal filters, tapped analog delay lines, and high-speed samplers/memory buffers, these inherently simple devices have proven to be powerful yet compact signal processing components.

For more than three years the CCD group at Tektronix has been developing a specialized set of devices to incorporate signal processing efficiency into Tektronix instruments. In the process we have developed one of the most advanced CCD technologies in the industry. This technology is available through a line of CCD products and design services.

Our CCD imagers are fabricated using a buried channel, three-phase, three-level polysilicon gate process. This approach results in extremely high charge-transfer efficiency and low background charge due to dark current. Our wafer-scale integration technology has made large pixel, large imagers a reality. An example is the TK2048M imager, shown. This imager has approximately 4.2 million picture elements (pixels), each of which is 10 to 100 times more sensitive than conventional high speed photographic film.

### Custom Devices

For custom designs our CALMA based, state-of-the-art CAD system, advanced microlithography capability—including wafer-scale E-beam mask making and three- or four-phase CCD processes—make it possible for you to design virtually any type of signal processing device. You can specify nearly any format of serial-parallel-serial CCD structures, optimized either for high speed or wide dynamic range, imaging or nonimaging. We also provide design and fabrication support for certain types of peripheral circuits including wide-band preamplifiers, high speed clock drivers, correlated-double-samplers, and timing/control logic.

If you've already completed a CCD design, Tektronix ICO provides a complete CCD foundry service to fabricate your device(s).

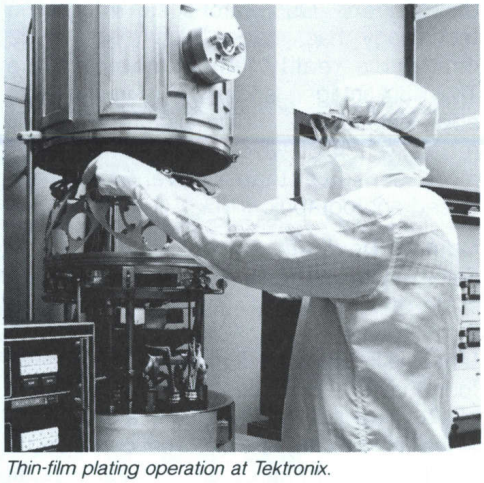
For further information, call:
ICO Marketing
Tektronix, Inc.
P.O. Box 500, D.S. 59-420
Beaverton, OR 97077
(503) 627-2515

## Custom Hybrid Technologies

The Tektronix Hybrid Components Operation provides complete design, engineering, manufacturing, and reliability testing for a wide variety of hybrid circuits and component subsystems.

HCO has produced hybrid components for Tektronix' instrumentation products for fifteen years. These include wideband amplifiers, D/A converters, signal acquisition probes, digital memory arrays, and numerous other hybrid devices. As required, Tektronix hybrid components incorporate both Tektronix custom silicon and a full range of chips available from the semiconductor industry including LSI bipolar and CCD ICs, as well as high stability passive components. An experienced staff specializes in custom design and production of high-density, high-speed, wideband circuits supported by modern computer aided design and evaluation tools. These resultant circuit designs offer high reliability, great design flexibility, and relatively short development times.

HCO hybrid manufacturing facilities include automated screenprint and fire processes plus modern automated equipment for die placement and wire bonding. We also offer functional laser trim and scribe, and extensive computerized electrical in-line testing.

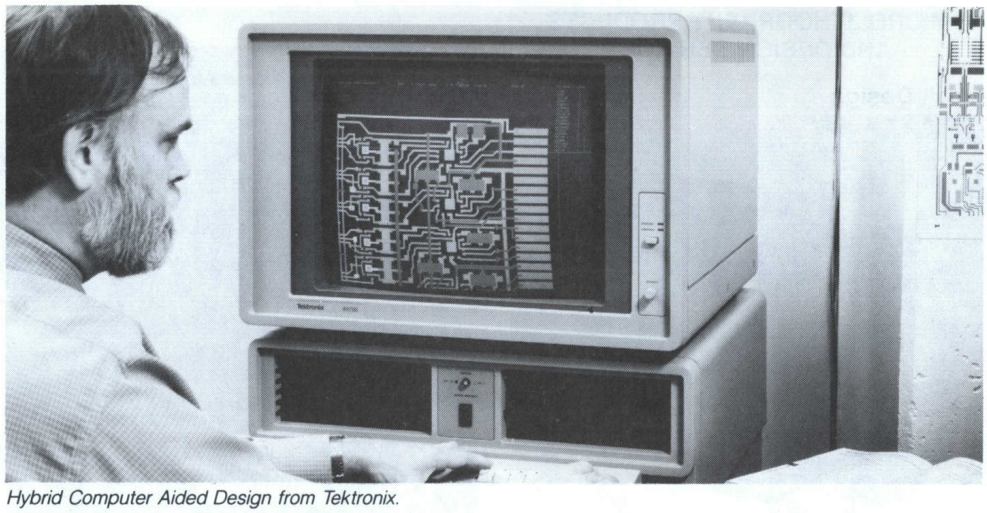


*Thin-film plating operation at Tektronix.*

## Thin-Film Process Capabilities

Hybrid Components Operation has established a reputation as a quality producer of high-speed, high-complexity hybrid circuits. In many cases these sophisticated circuit designs utilize thick-film chip-and-wire technology on a multilayer substrate. For an increasing number of hybrid designs, where operating frequencies fall above 500 MHz, thin-film techonologies are appropriate and cost-effective.

Tektronix' Thin-Film Operation is a new facility with modern automated equipment. All thin film processes necessary for substrate fabrication, assembly, and test are located at a single site. The facility includes automated systems for testing complex thin-film resistors and substrates.



*Hybrid Computer Aided Design from Tektronix.*

## Thick-Film Hybrid Technology

The HCO hybrid engineering and manufacturing staff at Tektronix provides extremely high-density thick-film chip-and-wire circuitry on mulitlayer substrates. High-density multichip multilayer substrates typically provide component densities of 25 devices per square inch.

For requirements of low-to-medium complexity with operating frequencies less than 500 MHz, standard thick film hybrid designs are the most cost effective. These Tektronix hybrid circuits have the fastest development cycle, the lowest development cost, and the lowest manufactured cost of any hybrid type.

## Custom Ceramic Capabilities

The Tektronix ceramic operation has historically developed and manufactured high performance ceramic components for Tektronix' products. A number of product families have evolved over the years which include multilayer ceramics, SLAM packages, custom substrates, lids and covers, a wide variety of ceramic insulators, powdered metal parts, powdered metal sputtering targets, and custom ceramic CRT envelopes. Now, HCO is extending its can-do attitude and broad technological experience to supplying ceramic solutions to the outside market. The ceramic group offers a wide range of finishing and metallizing skills, material systems, and forming processes that can be utilized in overcoming design and manufacturing problems and assuring on-time deliveries to our customers.

Specialized analytical services are available within Tektronix to support Ceramic Operation's ability to maintain close and consistent control over its materials and processes.

## HCO Electro Optic Capabilities

Tektronix Hybrid Components Operation is emerging as a leader in the development of electro optic packaging technologies. The HCO Electro Optic Group specializes in packaging components that perform in the multi-gigahertz range.

A laser diode module operating at 1300 nm (model LDM 1300) was recently introduced. This device is the first in a family of Tektronix standard electro optic products. Currently under development are laser diode component subsystems and packages that will integrate laser diode sources, detectors, amplifiers, and some passive components.

The Electro Optic Group has experience in custom design and development for many Tektronix applications including large active area CCD imaging arrays sustaining high performance requirements over a wide temperature range.

The Tektronix electro optic manufacturing facilities currently include semi-automated production lines dedicated to the medium volume production of the LDM 1300. These facilities include standard hybrid assembly systems capable of optical alignment to 1/10 of a micron and better.

## Quality and Reliability

The Hybrid Components Operation Quality and Reliability Department is a complete engineering and testing facility that provides a full range of mechanical, electrical, and environmental test capabilities. The group has expertise with standard reliability tests and with highly specialized reliability evaluation procedures. All hybrid components undergo reliability demonstration testing to assure conformance with customer specifications. There are a variety of test methods used that meet or exceed Military Standard 883C requirements. A unique set of tests and a testing sequence is generated for each hybrid type. The HCO Reliability Department has experience in testing a wide variety of hybrid circuit packages and processes.

## Expertise

Tektronix' Hybrid Components Operation offers you hybrid and ceramic expertise in research and development, design, engineering, materials development, and processing in a series of custom building blocks that may be configured to fit your product requirements.

**Customer Support**
Hybrid Components Operation
Tektronix, Inc.
P.O. Box 500, D.S. 13-810
Beaverton, OR 97077
(503) 627-4220

# LDM 1300 Laser Diode Module

**Gbit Lightwave Transmission**

**Stable Fundamental Transverse Mode; 1300 nm Emission Wavelength**

**High Reliability**

**True Hermetic Seal**

**Fast Pulse Response**

**Wide Operating Temperature Range**

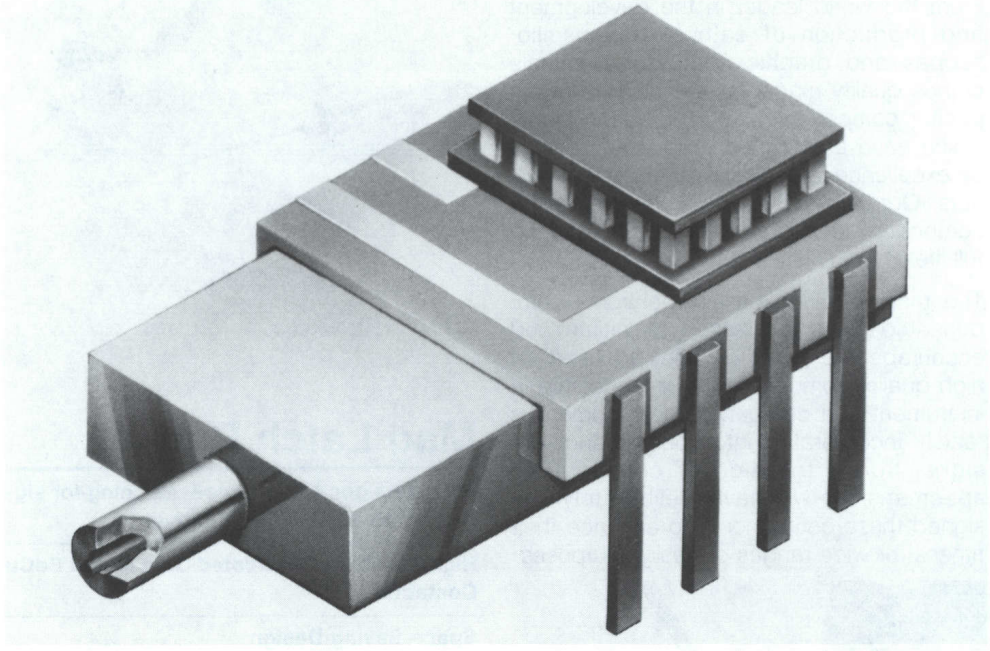
## TYPICAL APPLICATIONS

* **Optical Fiber Communications**
* **Integrated Optics**
* **Fiber Optic Sensors**
* **Local Area Networks**
* **Research and Development**

The Tektronix LDM 1300 Laser Diode Module is intended for high speed, long life, optical communications applications. The module includes a low threshold Double Channel Planar Buried Heterostructure (DC-PBH) laser, a photodiode to monitor back facet emission, and a calibrated platinum sensor which permits precise, linear control of the package temperature.

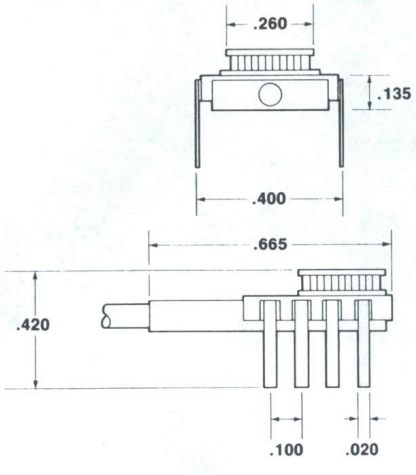
The module is supplied with a single-mode fiber pigtail. Installed connectors are optional. The LDM 1300 includes an external thermo-electric cooler.

Additional Tektronix instrument support for electro optic applications can be found in the communications product section of this catalog.



### ABSOLUTE MAXIMUM RATINGS ($T_C$=25°C)

| Parameters | Symbol | Ratings 1300 nm | Units |
|---|---|---|---|
| Storage Temperature | $T_{STG}$ | −65 to +100 | °C |
| Operating Temperature | $T_{OP}$ | −20 to +50 | °C |
| Fiber Output Power | $P_F$ | 2.5 | mW |
| Laser Reverse Voltage | $V_{RL}$ | 2 | V |
| Photodiode Reverse | $V_{RD}$ | 20 | V |
| Temperature Sensor Current | $I_{TS}$ | 1 | mA |




### ELECTRICAL AND OPTICAL CHARACTERISTICS ($T_C$=25°C)

| Parameters | Symbol | Test Conditions | Limits Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Threshold Current | $I_{TH}$ | CW | 15 | 25 | 40 | mA |
| Forward Current | $I_F$ | CW, $P_F$=1mW | | 40 | 60 | mA |
| Threshold Voltage | $V_{TH}$ | $I_F=I_{TH}$ | | 0.8 | 1.0 | V |
| Forward Voltage | $V_F$ | $P_F$=1mW | | 1.2 | | V |
| Fiber Output Power | $P_F$ | $I_F=I_{TH}$ + 35mA | 1.0 | | | mW |
| Lasing Wavelength | $\lambda_L$ | CW, $P_F$=1mW | 1280 | 1300 | 1320 | nm |
| Spectral Width | $\Delta\lambda$ | CW, $P_F$=1mW | | 3 | | nm |
| Monitor Current | $I_m$ | $P_F$=1mW | | 50 | 0μA | |
| Rise/Fall Time | $t_R t_F$ | | | 200 | | psec |
| Platinum Temp Sensor Resistance | $R_{TS}$ | $T_C$=0°C | | 100 ± 0.2% | | Ω |
| Temp Sensor Coefficient | | | | 37 | | Ω/°C |
| Characteristic Temp | $T_O$ | | | 85 | | °K |

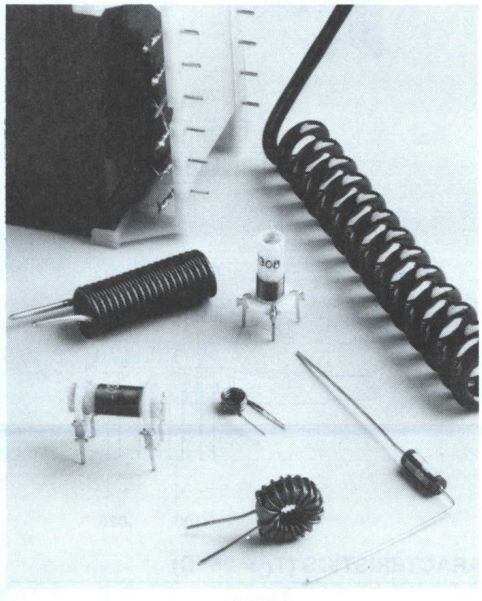
**Customer Support**
Hybrid Components Operation
Tektronix, Inc.
P.O. Box 500, D.S. 13-810
Beaverton, OR 97077
(503) 627-4220

NEW

# TEK MAGNETIC SWITCHING, CAPACITOR, INDUCTOR & TRANSFORMER COMPONENTS

From the world leader in the development and production of cathode ray oscilloscopes and graphic computer terminals comes quality magnetic, switching and capacitor components. Now the components which have established a 40 year tradition of excellence are available for your products. Our pursuit for quality begins at the component level and extends through the full life of the finished product.

The manufacturing arm of Tektronix component designs is pleased to initiate and encourage the trend of sales to users of high quality components. Our leadership in instrument and component development is readily incorporated into your product designs. In our tradition of conservative specmanship, we have deliberately designed these components to enhance their fitness for wide ranges of design purposes.



## Magnetic Components

**Fast Prototyping**

**Wide Application Experience**

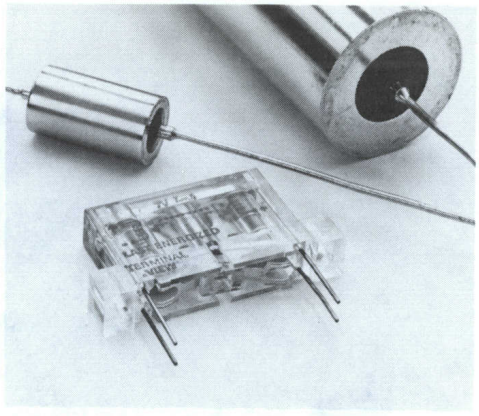
**Design Flexibility**

**Production Uniformity, Consistency**

**Performance Value**

Indicated range is for existing designs only. Custom designs available upon request.

| | Value |
|---|---|
| Coil: Fixed Tubular | 14 nH - 600 mH |
| Coil: Variable | 60 nH - 600 μH |
| Toroids: Inductors | 225 nH - 12 mH |
| Toroids: Transformers, RF | Multi-winding (7 Max) |
| Transformers: Power, Line Frequency | Class A (105)<br>Dual Tapped Primaries<br>Multi Secondaries - 600 V Insul<br>Power - up to 1 KVA, 47-400 Hz<br>Leads and/or Terminals, Various UL recognized transformers |



## Mag Latch Relay

**Maintains good impedance matching for signals up to 1 GHz in 50 Ω Circuit**

**High Reliability (Bifurcated Gold Plated BeCu Contacts)**

**Space Saving Design**

**Single or Dual Coil Drive**

**Ceramic or Standard Circuit Boards**

The Tektronix Magnetic Latching Relay is designed to offer highly reliable, low level switching without adding significant amounts of inductance, capacitance, and resistance to a circuit. It can be mounted directly on a hybrid circuit substrate or on a printed circuit board and consists of two 38 Ω drive coils and a unique open armature-contact system.

The Mag Latch Relay is suitable for input attenuator applications in portable and laboratory test equipment and provides an excellent method for remote low level switching in both manual and automatic instrumentation.

### CHARACTERISTICS

**Contact Life** — (At typical loads) $10^7$ cycles dry circuit (<10 mA and <50 mV dc); $10^6$ cycles at 250 mA and 30 V dc or peak ac; $10^5$ cycles at 250 mA and 250 V dc or ac RMS.

**Contact Resistance** — 0.1 Ω maximum overlife (typically 10 to 30 mΩ), depending on substrate contact material.

**Operating Time** — 1.0 ms typical, 6.0 ms maximum.

**Drive Voltage** — Single Coil: 7 V ±1 V (5 ms). Dual Coil: 11 V ±1 V (5 ms).

**Coil Resistance (Each)** — 38 Ω ±10% at 25°C.

**Coil Inductance (Typical)** — Magnetic circuit closed, 11 mH.

**Coil Operating Temperature** — 95°C maximum.

**Capacitance (Typical)** — Pad-to-pad (contact open) 1.0 pF.

**Contact Inductance (Typical)** — Closed contact 2.5 pH.

**Contact Bounce (Typical)** — 200 μs.

## Capacitors

**Close Tolerance, Stable**

**Low Dielectric Absorption**

**True Hermetically Sealed**

**High Insulation Resistance**

**Noninductive**

For over thirty years Tektronix has manufactured special application capacitors for input coupling, timing, frequency determining, charge hold, vertical divider compensating, calibration and waveform shaping.

Mylar, Polycarbonate, Polystyrene and Polypropylene in foil/film and metalized configurations is used to ensure stable values over time and temperature excursions.

### CHARACTERISTICS

Plastic dielectric, hermetically sealed extended foil film, and metalized construction.

#### TIMING AND WAVEFORM SHAPING CAPACITORS

| | Poly-propylene | Poly-styrene | Poly-carbonate | (Mylar) Polyester |
|---|---|---|---|---|
| Operating Temperature | −55°C to +85°C | −55°C to +85°C | −55°C to +85°C | −55°C to +85°C |
| Capacitance Value | 300 pF to 0.5 μF | .001 μF to 1.0 μF | 450 pF to 10.0 μF | .001 uF to 1.0 μF |
| Capacitance Tolerance*1 | ±1.5% to ±2.0% | ±1.5% to ±3.0% | ±1.5% to ±3.0% | ±3.5% |
| Dissipation Factor*1 | 0.1% | 0.1% | 0.3% | 0.4% |
| Voltage Ratings*2 | 25 V to 400 V | 25 V to 400 V | 25 V to 3,000 V | 100 V to 400 V |
| Set Matching Tolerance Band<br>Initial<br>End of Life | <br>--<br>-- | <br>0.25%<br>0.75% | <br>0.25%<br>0.75% | <br>0.5%<br>1.0% |
| Insulation Resistance*3 | 5 x $10^6$ MΩ x μF | 7 x $10^5$ MΩ x μF | 1 x $10^5$ MΩ x μF | 1 x $10^5$ MΩ x μF |
| Temperature Coefficient Range | −310 to 0 ppm/°C | −150 to 0 ppm/°C | −110 to +190 ppm/°C | 0 to +150 ppm/°C |
| Value Drift Through Life | -- | +0.30% | +0.40% | +0.50% |

*1 *1 kHz, 25° C.*
*2 *Dc working.*
*3 *1 x $10^9$ minimum. Typical value listed is at rated voltage, 1 minute charge time.*

#### INPUT COUPLING CAPACITORS

**Maximum Electrical Stress Noise** — One change <0.8 pF.

**Capacitance Value Range** — 0.019 μF to 0.1 μF.

**Operating Temperature Range** — −55°C to +85°C.

**Capacitance Tolerance** — −15% to 10%.

**Set Pairing** — 0.4% to 1.0%.

**Voltage Rating** — 400 V dc to 1000 V dc.

**Dissipation Factor** — 0.2%.

**Insulation Resistance** — 3 x $10^5$ MΩ x μF.

**Temperature Coefficient** — −100 to −200 ppm/°C

**Customer Support**
Tektronix, Inc.
P.O. Box 500, D.S. 19-013
Beaverton, OR 97077
(503) 627-3233

MAGNETIC SWITCHING, CAPACITOR, INDUCTOR & TRANSFORMER COMPONENTS

**Built on 35 years of experience in the design and manufacturing of advanced technology magnetic and electrostatic CRTs.**

For the first time Tektronix's proven quality, reliability and performance are available for your CUSTOM CRT needs.

**Ultra High Resolution**
Photographic Imaging
Medical/Diagnostics
Workstations

**High Brightness**
Avionic Color
Color Shutters
Air Traffic Control

**Ruggedized**
Mobile Military
Cockpit Displays
IR Viewers

## Avionics Color Cathode Ray Tubes

**High Resolution**

**Sunlight Readable**

Breakthrough mechanical design has resulted in a family of high quality shadow-mask color display tubes equally adaptable to both raster-scan and stroke-written modes of operation.

These daylight-bright high resolution ruggedized tubes are intended for electronic flight instrumentation systems (EFIS). The tubes meet or exceed the emerging requirements for EFIS display systems, including MIL-STD-810C for shock and vibration.

The Tektronix Avionics Display organization will quote, upon request, design iterations involving phosphor composition, tube size and shape, and complete assemblies.

For further information call:
Avionic Displays
Tektronix, Inc.
P.O. Box 500, D.S. 48-255
(503) 627-6882
Telex: 151754
TWX (910) 467-8708

## Monochrome Cathode Ray Tubes

**High Brightness**
Proprietary high beam current electron gun design and optimized phosphors provide a unique combination of brightness and resolution. A brightness of 3500 foot lamberts at 768 x 1024 resolution is achievable in a 9 inch display.

A clam shell yoke design and low grid drive capacitance gives low power consumption and high deflection sensitivity.

**High Resolution Direct View**
Our unique electron gun design, dynamic focus and astigmatism correction elements provide optimum resolution over the whole screen.

Resulting spot sizes, 2048 x 2730 addressable pixels, approach the resolving power of the human eye at a viewing distance of 24 inches. Our patented low-capacitance grid structures allow the display designer to utilize this resolution capability.

**Ultra High Resolution**
Tektronix state of the art capabilities in phosphor formulation and deposition provides the low blemish, high uniformity screens necessary for critical display applications. Spectral output can be optimized for photographic and other requirements.

Our gun designs are capable of achieving spot sizes of less than 0.001 inch in screen sizes up to 9 inches. Internal correction elements maintain a uniform, spot size over the entire screen.

**Customer Support**
Monochrome CRTs
Tektronix, Inc.
P.O. Box 500, D.S. 46-539
(503) 627-6868
Telex: 151754
TWX (910) 467-8708

# TEK LCS PROFESSIONAL COLOR GRAPHICS SYSTEM

## LCS

**Professional Color Graphics System**

**For IBM Personal Computer AT**

**Higher Resolution & Contrast**

**Enhanced Edge Acuity**

**Large Usable Viewing Area**

**Very Fast Writing/Image Rendering Speed**

**High Level Graphics Support**

**Enhanced Text Generation**

Liquid Crystal Shutter (LCS) technology developed at Tektronix has made possible an advanced color graphics display system for the IBM Personal Computer AT. Aimed at the CAE/CAD/CAM market, the LCS Professional Color Graphics System gives the IBM PC/AT advanced graphics capabilities for a wide range of technical applications. The LCS system also supports existing software written for the IBM machine.

The LCS Professional Color Graphics System comes complete with a high resolution 12-inch diagonal LCS/CRT display, a high performance color graphics controller card, and an IBM PC emulator card.

## TECHNICAL DATA

### TEK LCS 1220 COLOR GRAPHICS DISPLAY

The Tek LCS 1220 Color Graphics Display provides high resolution, high contrast graphics for the IBM Personal Computer AT.

**CRT —** 12-in. diagonal, 90°, 0.013 in spot size.

**Input Signals —** Analog input, positive video, 1 V p-p max.

**Video Bandwidth —** 51 MHz

**Scan Frequencies —** Horizontal: 61 KHz. Vertical: 120 Hz.

**Display Size —** 9.75 in. x 7.25 in.

**Display Resolution —** 640 pixels x 480 lines (non-interlaced).

**Contrast Ratio —** Greater than 15:1 in office environment.

**Primary Colors —** Red, green and any combination of red and green.

**Input Connector —** 9-pin (cable supplied).

**Operating Temperature —** 0°C to 40°C.

**Power Source —** 90 V ac to 136 V ac, 48 Hz to 62 Hz (180 V ac to 250 V ac, 48 Hz to 62 Hz optional.)

**Power Consumption —** Less than 100 W.

**Power Cable —** IEC connector to fit monitor power plug on IBM PC/AT (cable supplied).

**Compatability —** Tek LCS C480 Color Graphics Controller Card, Tek LCS E480 Emulator Card.

**Prerequisites —** IBM Personal Computer AT and Tek LCS C480 Color Graphics Controller Card and/or Tek LCS E480 Emulator Card.

**Installation —** By customer, using instructions provided.

### TEK LCS C480 CONTROLLER CARD

The Tek LCS C480 Color Graphics Controller Card plugs directly into an IBM Personal Computer AT, providing advanced graphics capabilities for the Tek LCS 1220 Color Graphics Display.

**Video Output (Bi-primary, Field-sequential)**

**Color Frame Rate —** 60 Hz square wave.

**Horizontal Sync Rate —** 61 k Hz.

**Vertical Sync Rate —** 120 Hz.

**Z-Axis Analog Video Output —** 1 V p-p into 75 Ω.

**Performance**

**Addressed Resolution —** 640 pixels x 480 lines (non-interlaced).

**Pixel Rate —** 50 MHz.

**Bits/pixel —** 4 bits/pixel.

**Z-Resolution —** 8-bit color palette in each field.

**Color Palette —** 16 colors selectable from palette of 65,000.

**CRT Control —** Drawing speed up to 8000 vectors/sec.

**High Level Graphics Primitives —** a complete set is supported in hardware and software.

**Frame Buffer Size —** 128 K words (512 K pixels) standard. [512 K words (2 M pixels) optional.]

**Mechanical —** Standard IBM PC/AT card form factor.

**Operating Temperature —** 15.6°C to 32.2°C.

**Prerequisites —** IBM Personal Computer AT and Tek LCS 1220 Color Graphics Display.

**Installation —** By customer, using instructions provided.

### TEK LCS E480 EMULATOR CARD

The Tek LCS E480 Emulator Card converts 200-line display software (e.g., Lotus 1-2-3, dBase III, MultiMate, etc.) to a 400-line display offering the following features:

**Addressed Resolution —** 640 pixels x 400 lines (non-interlaced).

**Color Palette —** 16 colors.

**Mechanical —** Standard IBM PC card form factor.

**Operating Temperature —** 15.6°C to 32.3°C.

**Prerequisites —** IBM Personal Computer AT and Tek LCS 1220 Color Graphics Display.

**Installation —** By customer, using instructions provided.

IBM PC/AT is a registered trademark of International Business Machines Corp.
dBASE III is a registered trademark of Ashton-Tate.
MultiMate is a registered trademark of Multimate International Corp.
Lotus 1-2-3 is a registered trademark of Lotus Development Corp.

## ORDERING INFORMATION

**LCS Professional Color Graphics System** **$3,500**
**Includes:** Tek LCS 1220 Color Graphics Display, Tek LCS C480 Color Graphics Controller Card and Tek LCS E480 Emulator Card.

**Tek LCS 1220 Color Graphics Display** **$825**
**Option 01 —** 180 V ac to 250 V ac, 48 Hz to 62 Hz Power Source. **+$50**

**Tek LCS C480 Color Graphics Controller Card** **$1,925**
**Option 02 —** 512 K Words (2 M Pixels) Frame Buffer Size. **+$500**

**Tek LCS E480 Emulator Card** **$750**

OEM discounts are available.

**Customer Support**
Liquid Crystal Shutter Marketing
Tektronix, Inc.
P.O. Box 500, D.S. 46-556
Beaverton, OR 97077
(503) 627-5000

*The 4120 Series Color Graphics Workstations provide 2D graphics, 3D wireframe and 3D shaded surface modeling systems.*

*The 1241 Logic Analyzer's color interface quickly guides your eye to the most relevant information.*

## TEK Means...Getting the Picture

**with color enhancement, the power of intelligence, system integration, software and more . . .**

### Display Technology—an integral part of our business

For forty years decades, Tektronix has designed and manufactured advanced electronic products, starting with cathode-ray oscilloscopes. Our innovative design efforts developed features such as the flat-faced CRT, the direct-view storage tube (DVST), the high-resolution liquid crystal shutter display (shown above), and the microchannel-plate CRT. The latter is incorporated in our 7104 "Gigahertz" oscilloscope, which remains unapproached in bandwidth and performance after eight years in the marketplace.

### We're the leader

We placed affordable graphics in the hands of engineers and scientists in 1971, using our experience in DVST design, (in lieu of the then high-cost of computer memory). Our PLOT 10 software early on became the de facto standard. Today, Tek PLOT 10 is installed on more computers than any other graphics utility library in the world. Our up-to-date graphics line covers a broad spectrum of needs.

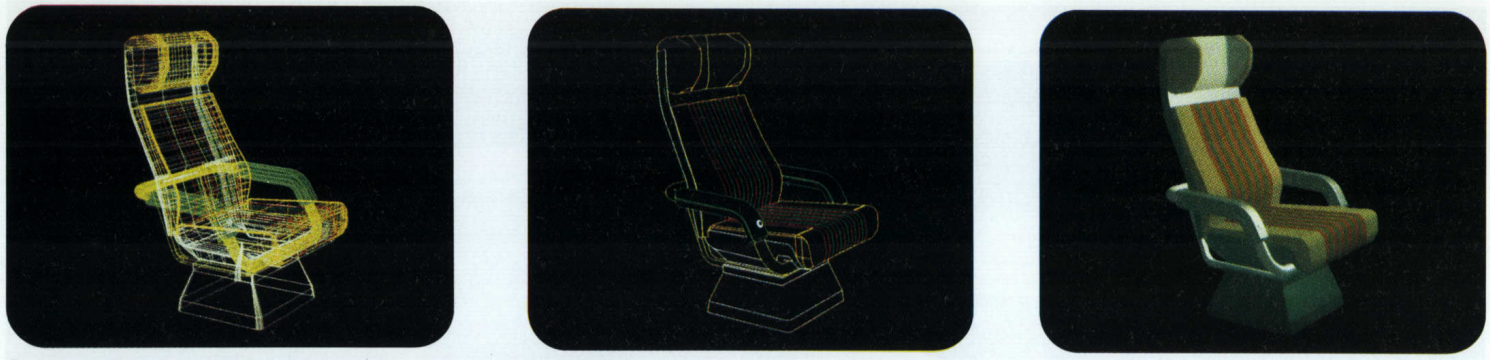
Color aids in differentiating dense graphics. Displays with default color tables (and color interfaces to modify colors to your specific application) eliminate viewability problems. Our Imaging Research Lab is developing standards based on human perception and reaction to color.

### Meeting Expanding Customer Needs

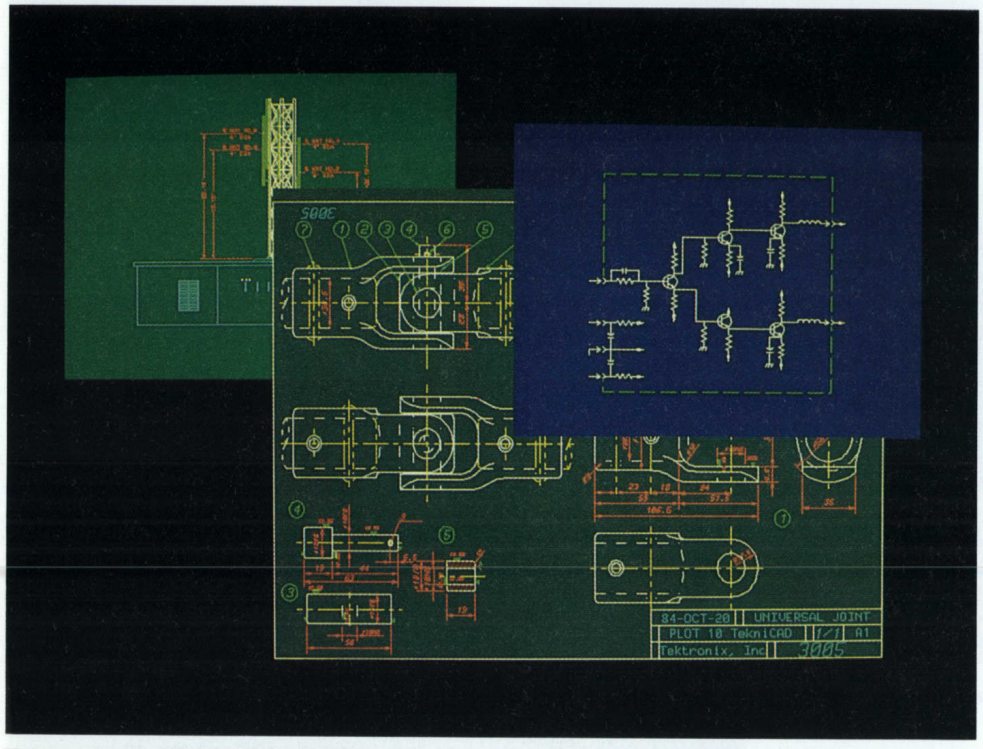
Our products are developed to fill your needs. Tek continues as an industry leader for product line breadth, range of price/performance options, and service support. Tek innovation, reliability and flexibility are built into all our products, which continue to set standards around the world.

### Our Products Have a Lot to Display

Computer graphics is no longer constrained to simply drawing pictures or plotting data, but is emerging as an effective, efficient human interface to computers.



**General Electric CAE International Inc. SDRC I-DEAS**




**Tektronix PLOT 10® TekniCAD**

The high quality graphic capabilities that were made available to an extensive line of host-based graphic terminals are now available in our powerful intelligent workstations (large photo). Tedious manual digitization of engineering drawings is eliminated with a Tek graphic input workstation. And, Tek color copiers produce hardcopy with resolutions that exceed terminal resolution. Our expanded line of artificial intelligence family increases productivity in many areas of Research and Development including expert systems, natural languages, and automatic programming. Our color terminals enhance operation in a number of areas, such as single key stroke access to the powerful TNIX operating system and Tek's microcomputer design tools. Here, softkeys simplify command entry and minimize keystrokes. A choice of color terminals is also offered for our acquisition/processing measurement systems. Our newest spectrum analyzer even provides a CRT display of operator "helps," in a choice of plain English, plus optional French, German, or Spanish. This year, more than any other, we've got a lot to display.

## Color Perception

The physiological fact behind color's continued success in displays is that the brain has two separate channels for processing visual information: one chromatic, the other achromatic. In many instances, data from both processing channels is used to interpret an image. An achromatic display deprives the operator of one entire visual data channel. Without this chromatic data flow, the brain's processing power is reduced, especially when interpreting complex visual information. The use of color substantially improves the readability of electronic instrument displays.

Color is particularly beneficial when viewing a complex display with high information density.

First, color can be used to organize information into logical groupings. High-priority items can be coded one color and low-priority items another.

Second, color can be used to locate information. This is especially useful when small but important items might be visually lost in a mass of other information.

Third, color can attract attention. Finding a single element in a complex array is easy when a color difference exists. A specific color can be associated with a particular class of events, such as red for warning or yellow for critical information. Color also allows a single instrument to function in different modes with a particular color unambiguously signaling the mode.

Fourth, color definitely has a high aesthetic appeal which reduces the monotony of prolonged display viewing. Although only subjective reports substantiate this aspect, color appears to enhance productivity by reducing boredom and fatigue.

## Ergonomics of Color

Through technical improvements and cost reductions, color has now become a potentially powerful tool for improving the instrument/user interface. Yet, the misuse of color can make the interface more difficult instead of easier.

Color is a product of human perception, the result of the eye reacting to "visible" wavelengths of electromagnetic radiation. The optical and sensory mechanics of the eye give color its three basic qualities:

Hue, which identifies the color in relation to other colors in the spectrum, such as red, yellow, green, etc.

Saturation, which defines the "purity" of color. As spectral colors become less pure, they appear more gray or white.

Lightness, which refers to the relative strength of the light coming from the color, as perceived by the observer.

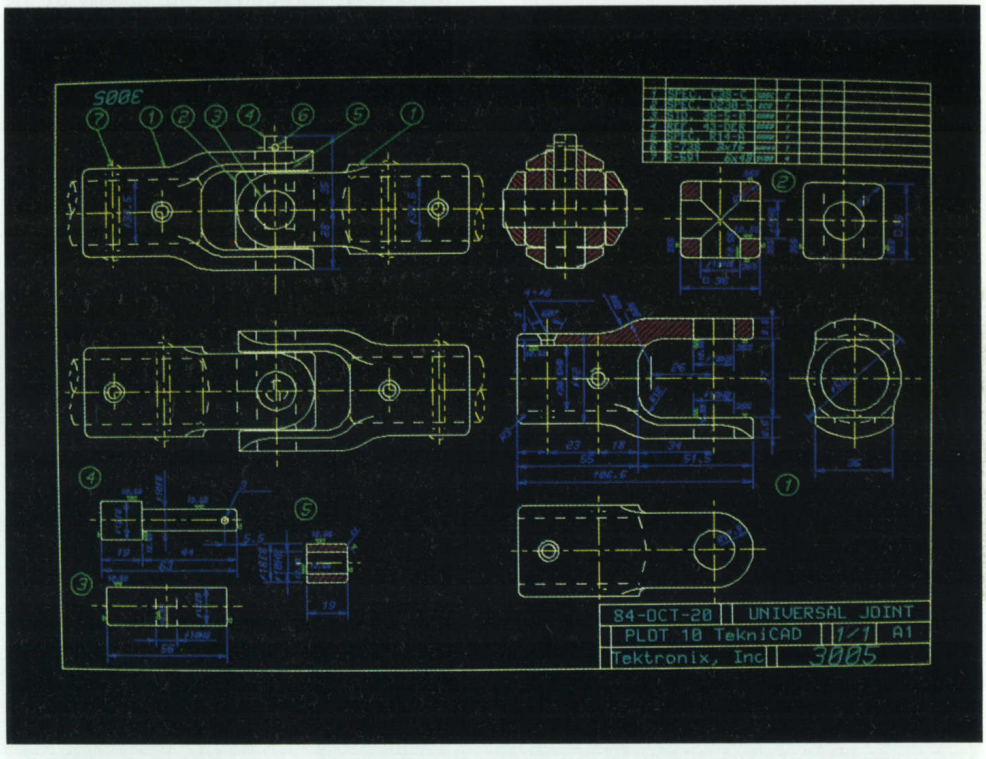
As the wavelengths of visible light change, the eye perceives a changing hue that produces the familiar spectral colors, ranging from deep red through yellow, green, and blue to purple. At any given wavelength, a "pure" color is produced that yields maximum saturation. Pure colors can be desaturated by increasing lightness until the color is "washed out."

**MCS ANVIL-400®**

Color distribution and saturation play an important part in color perception. Colors widely separated in the spectrum, such as red and green, are much easier to discriminate than neighboring colors. Also, "grayish" colors of low saturation become difficult to separate. On the other hand, highly saturated colors that are also widely separated in hue require the eye to refocus, which can be a source of fatigue. Another important consideration is that the eye's foveal region, which yields maximum visual resolution, is essentially "blind" to the color blue, making it a poor choice for presenting detailed information.

## Color Display Characteristics

Image quality and information handling capability are the two broad categories of characteristics that are important to users of color displays. Image quality includes optical characteristics like resolution, edge sharpness, brightness, contrast and color quality. Environmental "noise" can cause undesirable optical characteristics of displays, such as flicker, jaggies, and moire patterns. Information handling capability includes characteristics like display size, number of vectors or pixels, and number of colors.




**Tektronix PLOT 10® TekniCAD**

### Resolution

The quality of the image is strongly affected by the resolution of the display system. However, the term resolution is often used synonymously with the number of scan lines (addressability) in discussions of raster displays. Resolution refers to the display's ability to resolve or separate two closely spaced points, lines, or spatial frequencies. Resolution is the essential characteristic that determines image sharpness. The resolution of a display comprises a combination of elements including spot size, spot profile, dot spacing, number of scan lines and bandwidth. Addressability, on the other hand, refers to the display's ability to position lines or pixels anywhere on the screen. A display may have addressability that exceeds its resolution capability and so will not affect the resolution of the display. However, if the addressability is not high enough, it will affect the resolution of the display in complex images.

## Color Display Technology

The CRT is the most important factor in determining characteristics of a color display. Tektronix color display technology produces three basic types of CRTs: the shadow-mask CRT, the liquid-crystal (LC) CRT System, and the Direct View Storage Tube. The choice of CRT and display system is determined by the user's needs and application. For any particular color display application, the user is concerned with image quality and information handling capability relative to that application.

## Information Handling Characteristics

### Size

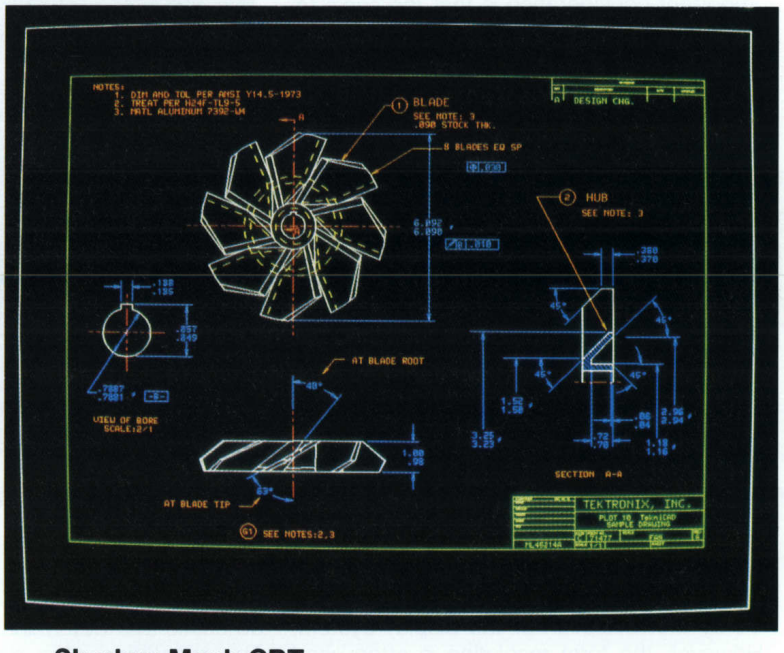
The ultimate size of color displays using DVSTs and shadow-mask CRTs is about 636 mm (25 inches) diagonally. The DVST can also be made quite small (152 mm or 6 inches) and still provide a large number of vectors because the spot size can be scaled down accordingly. The number of vectors in the color refresh mode is not limited by the resolution, but by the deflection speed required to write the vectors at a flicker-free rate. To display a large number of vectors, the deflection system must have a very high bandwidth, usually at the expense of power. However, the DVST avoids the need for high power with large numbers of stored vectors, though it faces the same trade-off for the refreshed color vectors.

### Number of Colors

The DVST with CWT has a maximum of three colors. Only the shadow-mask CRT offers a full range of colors. The color capabilities of a shadow-mask CRT are usually determined by the choice of phosphors for the three primary colors.

The DVST with CWT is very useful where complex images are to be displayed and color is needed only to highlight areas of the display. The shadow-mask raster display is by far the most prevalent type of color display in use today.

An attractive feature of a color terminal is its ability to display images in the desired colors. But how does one go about selecting a specific color and describing it to a terminal in meaningful, precise terms? Interactively, the user specifies a color and the terminal displays it. The user evaluates the displayed color and corrects it if necessary.



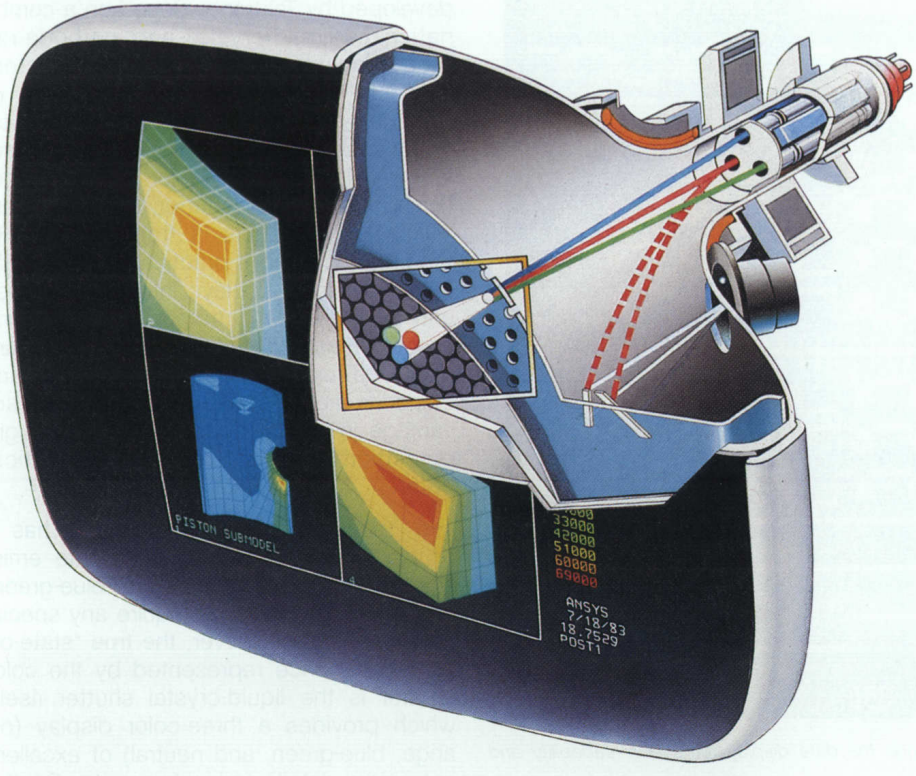

## Direct-View Storage Tube

Both the DVST with CWT and shadow-mask types of color displays reflect and scatter about the same amount of room light, so display contrast is determined by trace brightness. Display contrast can be improved by placing a filter in front of the display screen that will attenuate the emitted light less than the reflected light, which must make a double pass through the filter. Selective filters are also used to absorb room light while transmitting the emitted light from the display. Antiglare screens, which have either a special coating on the front surface or a matte finish to prevent specular reflections, are also used to improve display contrast.

## Shadow Mask CRT

The shadow-mask CRT is the most commonly used type of CRT for color displays. In fact, the shadow-mask CRT is the type used for home television and for studio television picture monitors. Usually, three electron guns are used to address three primary color phosphor dots or stripes. The dots are spaced close enough so they appear as one. Colors other than the three primary colors result from proportional mixtures of the individual dots. A shadow mask is used to make sure that each beam addresses only its assigned color dot. The beams from the red, green, and blue guns must pass through the mask openings at the proper angles to strike their corresponding phosphor dots.

The three beams are deflected together over the phosphor screen in a raster pattern.




*The 4115B's patented AutoConvergence is accomplished by applying non-parallel indexing phosphors at precise angles and positions at the rear of the CRT shadow mask.*

One of the most important factors in the recent evolution of computer graphics has been the emergence of high resolution, low cost raster displays. We've overcome the problem of CRT flicker with 60 Hz noninterlaced monitors. Raster technology is pushing the limits of human perception.

In other systems (e.g., home television), an interlaced raster is used. An interlaced display scans every other line in the first pass from top to bottom, then returns to the top and scans the intermediate lines in the next pass. A color image is drawn on the screen by the display system, which determines when each of the three electron guns receives current, and how much, and thereby how much of each color is produced at each point (pixel) on the screen.

When a shadow-mask CRT is used in graphics applications, a bit-map memory is used to store the image. The pixel information from the bit map is read out to the three electron guns in synchronism with the raster pattern of the beams. To produce an image on the CRT screen, the desired vectors and other shapes must first be converted into the proper pixels in the bit map using a scan conversion process. Algorithms are used to code the various shapes into several digital bits, representing the brightness desired at each pixel location on the screen.

Information in the bit map must be read out repeatedly to the CRT at a rate fast enough to avoid flicker. Therefore, the time required to change images on the screen is determined by how fast the scan conversion process can reload the bit map. The larger the bit map, the slower the reloading process; thus, raster images with a large number of pixels must trade off speed of interaction. As the number of pixels increases, so does the rate at which information is clocked out of the bit map. The deflection speed of the CRT beam and the bandwidth of the CRT video amplifier must increase accordingly. Deflection speed and video amplifier bandwidth ultimately limit the number of pixels possible.

### Color Purity and Convergence

Color purity generally refers to the uniformity that a color has over a large area of the display screen. Purity is a measure of whether or not the primary colors selected by the individual beams are spectrally pure. If some electrons meant for the red dot impinge upon the green dot, then the primary color is not pure. Purity is not really much of a problem in shadow-mask CRT displays. Each of the three beams should excite the entire phosphor dot when the beams pass through the shadow-mask holes properly.

High resolution displays introduced another new problem: *misconvergence*. When the display is not properly converged, a line written as yellow, for example, comes up with a red and green fringe on either side. Misconvergence which was simply annoying on the previous new generation of high resolution displays has become a source of potential misinformation on the new generation of high resolution displays. In fact, the convergence specification over the entire active area of the display becomes the effective resolution limit. That is, a 1000 line display is not useable as such unless the convergence specification insures no detectable misconvergence anywhere on the screen.

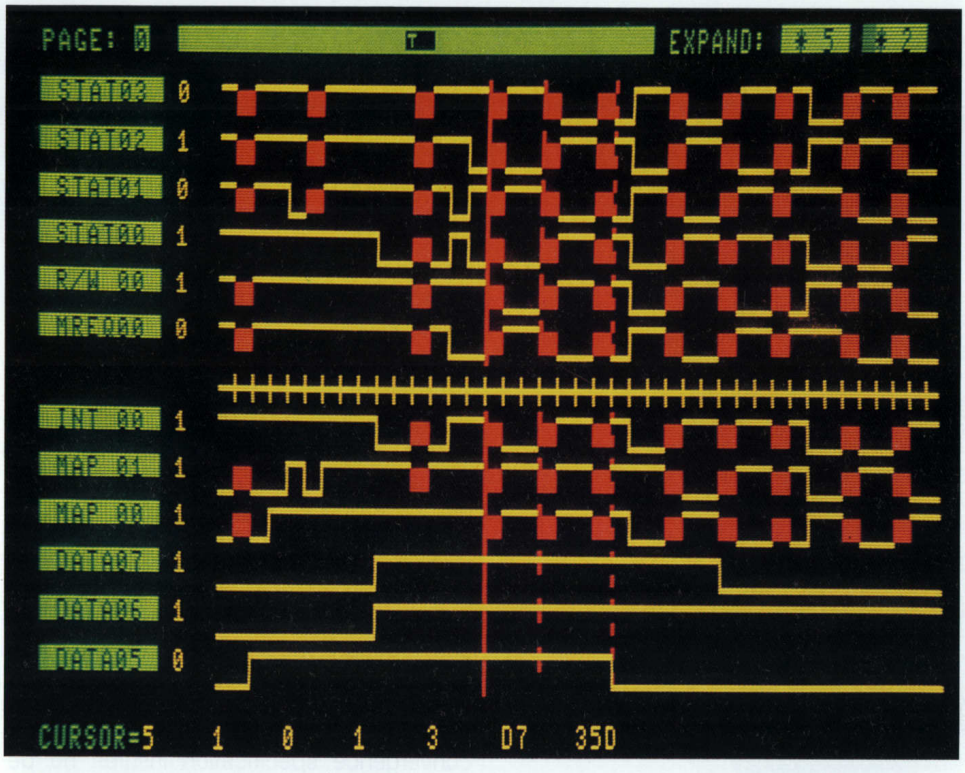
### AutoConvergence

The 4115B Computer Display Terminal contains a first-of-its-kind convergence feature that automatically corrects the natural drift occurring in the convergence of the color raster writing beams (shown above). Convergence is controlled to within 0.2 mm over the entire display area, resulting in sharper characters, lines, and colors. Technical skills are not required to maintain optimum convergence.

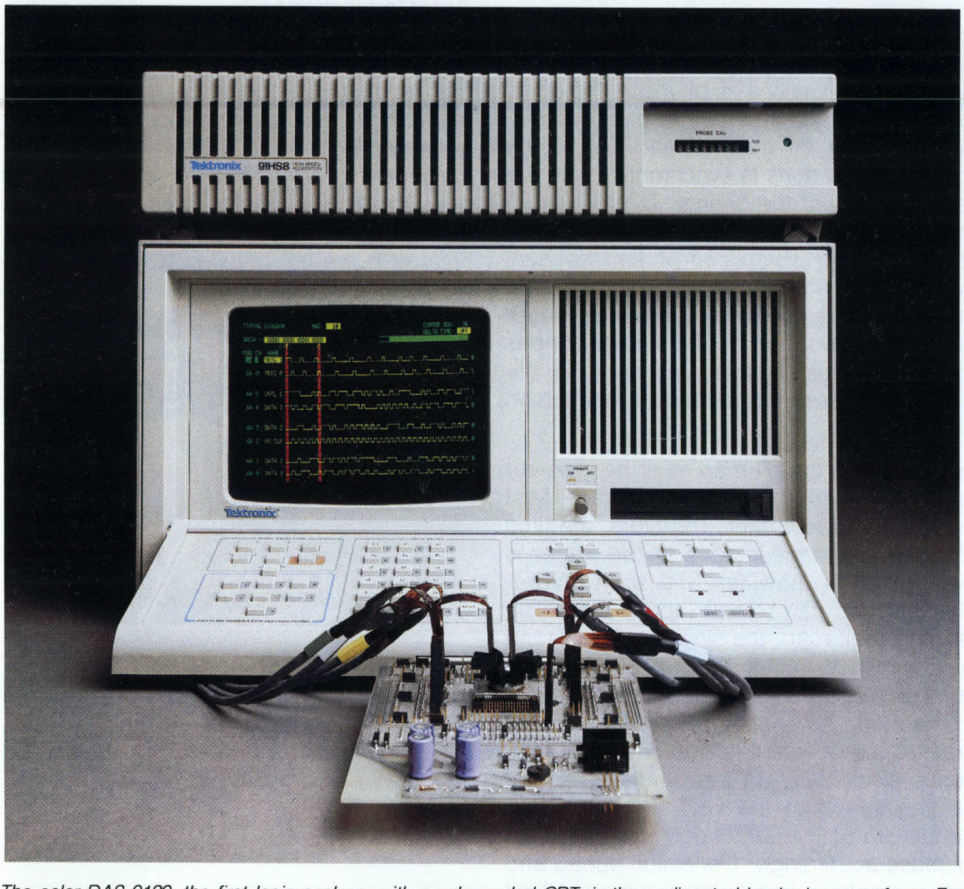
### Dynamically Converged Display

Dynamic convergence correction adjusts as the electron beam scans, providing convergence accuracy of 0.3 mm over the entire display area.

## Liquid-Crystal Color Display (The Color Shutter)




*The 1241 Logic Analyzer uses the LC/CRT system to enhance the data display for easier readability and comprehension.*



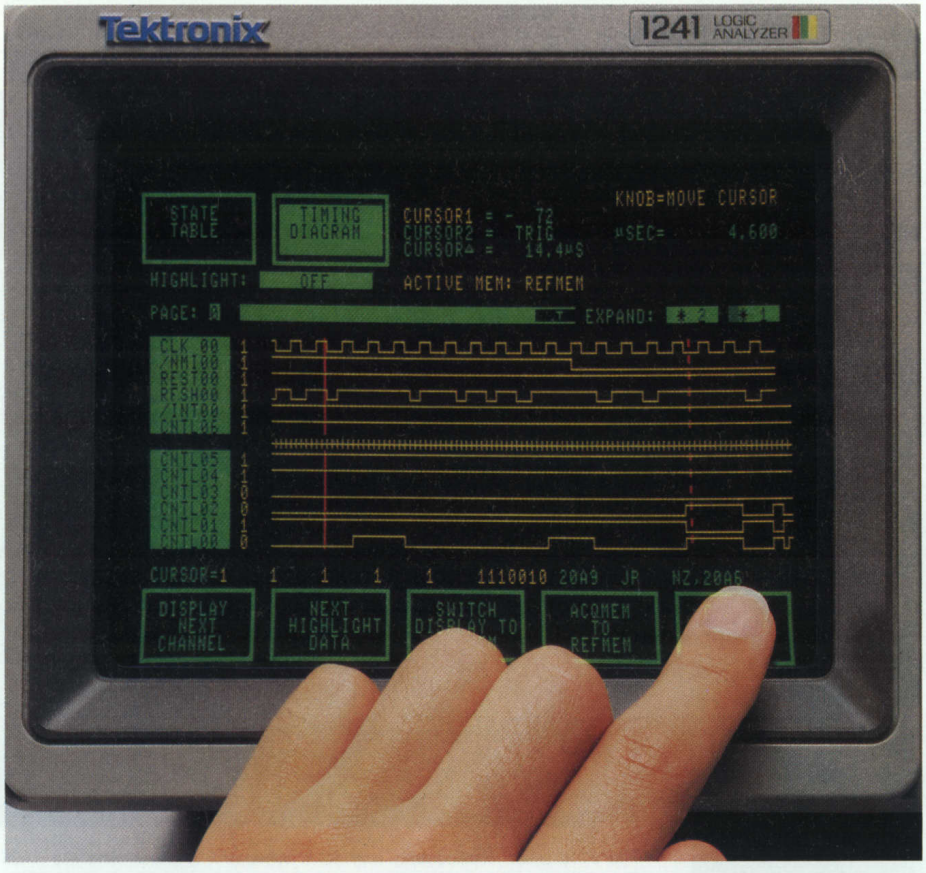

*The color DAS 9129, the first logic analyzer with a color-coded CRT, is the undisputed leader in ease-of-use. Each menu is organized into color groups for faster interaction, better understanding, and fewer errors.*

A method of producing color displays without shadow masks, color-dot phosphors, or any of the other usual techniques has been developed by Tektronix. Based on a combination of liquid-crystal and cathode-ray tube technologies, this LC/CRT system (see left) combines a black and white or "monochrome" CRT and a liquid-crystal "color shutter" to produce a very-high-resolution, field-sequential color display. Functioning as a color shutter, this very fast switching device fits in front of the CRT face, thus making it practical to build high-resolution color displays into oscilloscopes and other display instruments. Because no shadow mask or patterned phosphors are used, the resolution can be as high as any monochrome CRT. This is a particular advantage in small display sizes where high-resolution color has not been practical before.

The "monochrome" CRT employed has a simple phosphor with two separate emission peaks that are orange and blue-green. The phosphor does not require any special process steps. However, the true "state-of-the-art" advance represented by the color shutter is the liquid-crystal shutter itself, which provides a three-color display (orange, blue-green, and neutral) of excellent crispness, detail, and color purity. On the 5116 color oscilloscope, the LC shutter is basically a sandwich consisting of a color polarizer, a variable-retardation liquid-crystal cell, and a linear polarizer. The LC shutter consists of two glass plates coated with indium tin oxide for the transparent conductor, a thin layer of silicon dioxide for an insulator, and a special "alignment" layer that causes the director (essentially the major axis of the liquid crystal) to tilt in the same direction on both surfaces.

### Field-Sequential System

Previous efforts to produce a field-sequential system have suffered from the lack of a suitably fast color shutter. Earlier attempts at fabricating LC color shutters have used simple twisted nematic (liquid crystal) devices or dual-frequency nematic devices. The simple LC devices generally have relaxation times (essentially the time to switch from one polarization state to another) that are much longer than several milliseconds and are not suitable for fast switching applications. Flicker-free operation of a sequential two-primary-color display requires field rates of 120 Hz, for example, which in turn requires LC shutters capable of millisecond transition times for both the on and off states. Dual-frequency devices can have sufficiently fast response but require the use of drivers that must deliver a high-frequency signal into a large capacitive load.




*The 1241 Logic Analyzer's color display allows rapid set-up and operation. Touch-screen soft keys provide high-level commands at a keystroke.*

Employing a field-sequential system with displays having cells switched at a single frequency overcomes the need for high-voltage switching, a drawback of the dual-frequency cell approach. Typical dual-frequency cells are turned on with a low-frequency burst and turned off with a high-frequency signal, while the variable-retardation cell's elements are controlled by a single frequency. As a result the driving waveforms are simpler, and the driver's power requirements are less.

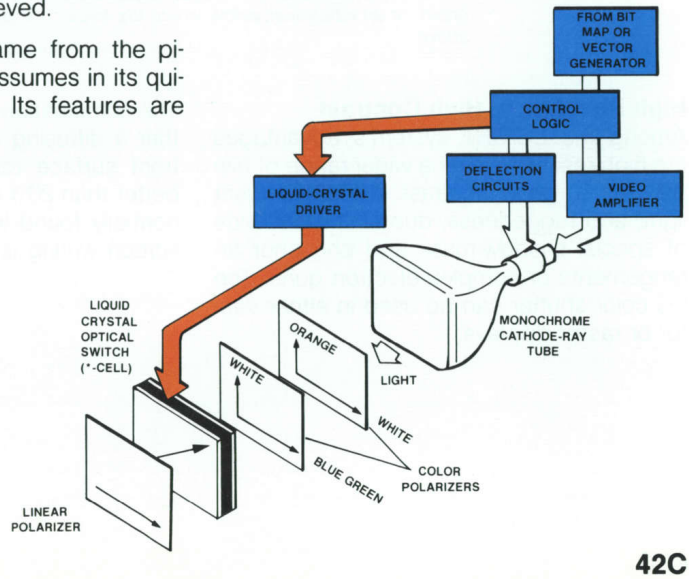
In any one field the information written on the screen appears only in the color selected by the LC shutter. The field-sequential system can provide all possible mixtures of the two primary colors contained in the phosphor. Each color or information field is displayed at a 60-Hz repetition rate.

### The Pi Cell

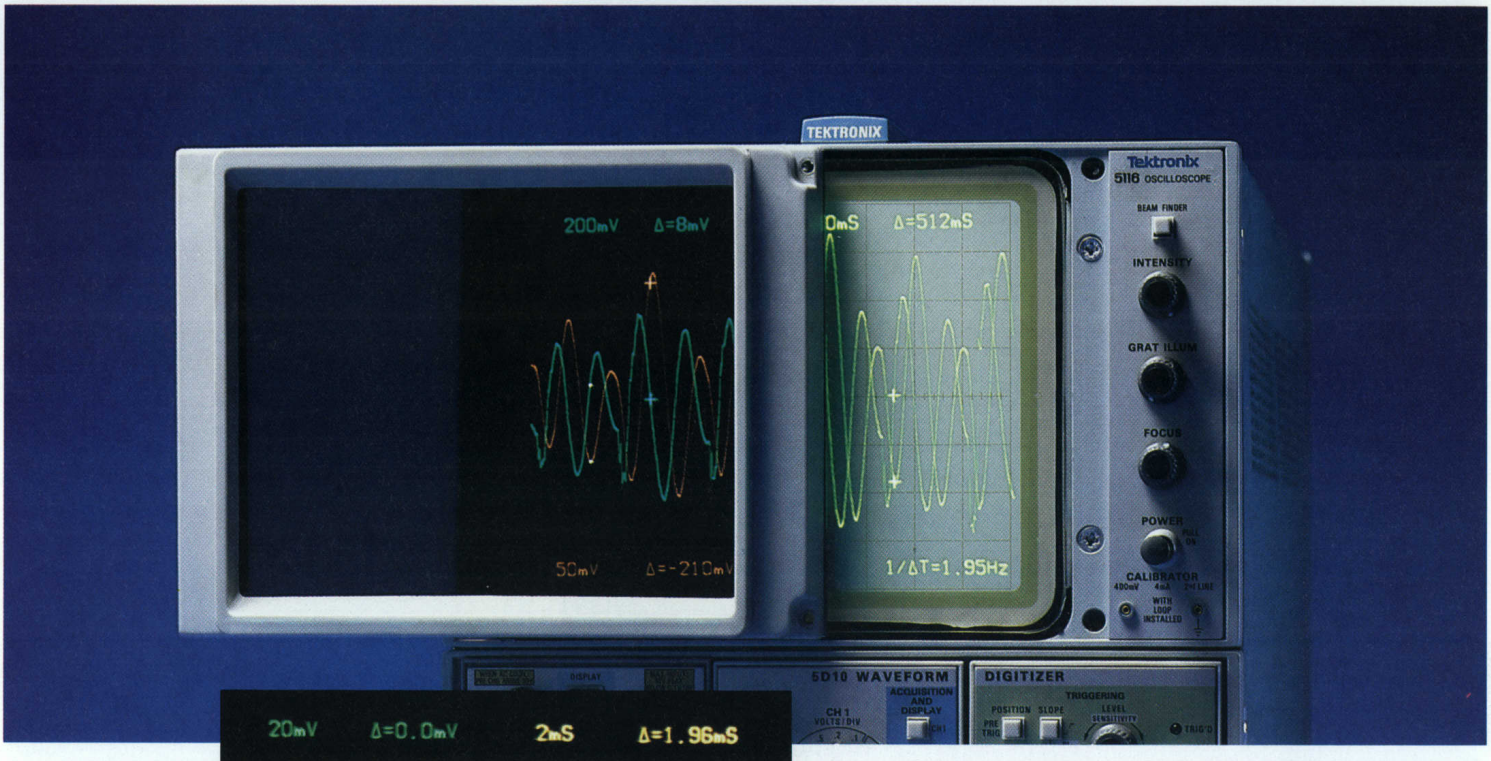
The variable-retardation cell (called a pi cell) is sandwiched between a set of red and green color polarizers and a linear polarizer at the output, and its axis is tilted 45 degrees with respect to the polarizers. The color polarizer orthogonally polarizes the orange and blue-green components of the CRT's emission, and the pi cell is used to sequentially rotate the polarized orange and blue-green information into the transmission axis of the linear polarizer. Rotation of the orange and blue-green information is performed in synchronization with the fields of the sequentially addressed CRT. Alternate fields, viewed through different colored polarizing filters, are integrated by the eye to give color images. By varying the z-axis modulation, the full range of colors that lie along the line connecting the orange and blue-green peaks of the phosphor's emission spectrum on the chromaticity diagram can be achieved.

The pi cell derives its name from the piradian amount of twist it assumes in its quiescent or undriven state. Its features are achieved by speeding the relaxation time of an already fast untwisted birefringent variable-retardation cell, whose liquid-crystal elements are homogeneously aligned.

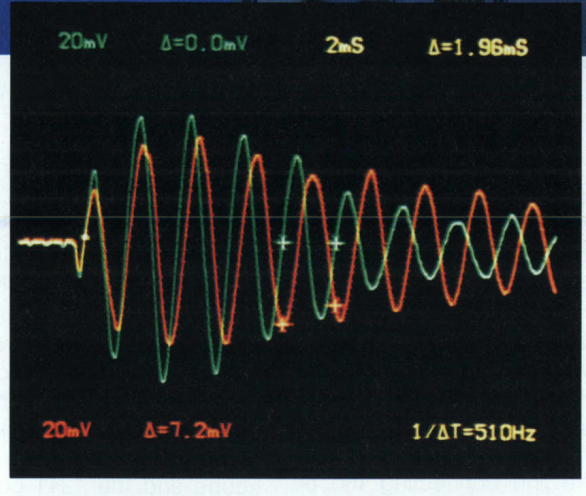
It is advantageous to keep the cell as thin as possible, since this results in a large angle of view, but narrowing the cell too much prevents achievement of the full half-wave retardation that is required. For LC shutters, such as used in our 5116 Oscilloscope and the 1241 Logic Analyzer, there is no perceptible color shift over the normal viewing angle.



# Low Cost, High Resolution, Easily Discernable Multichannel Displays




*The 5116 Color Oscilloscope with 5D10 Waveform Digitizer, and the 5A26 Dual Differential Amplifier. See page 246.*




*Control logic drives a liquid-crystal switch that, by twisting light coming through two filters, lets the linear polarizer filter out emissions from a monochrome CRT. The eye integrates them into orange, blue-green, or an inbetween yellow where the traces overlap, as shown above.*

**High Resolution, High Contrast**

Among the LC/CRT system's advantages are high resolution over a wider range of display sizes, good contrast in high ambient light, and ruggedness, due to the absence of special shadow-mask and phosphor arrangements or complex electron guns. The LC color shutter can be used in either vector or raster displays.

The combination of the color shutter and either a diffusing or an antireflection coated front surface can yield contrast ratios of better than 20:1 in the high ambient lighting normally found in today's offices. Since all screen writing is accomplished by a single electron beam, rather than by three beams as in a shadow-mask display, the LC shutter does not have misconvergence problems. This enhances resolution and produces a very readable display of text and complex graphics.

# INFORMATION DISPLAY PRODUCTS

## CONTENTS

Intelligent Graphics Workstations ..... 50
Computer Display Terminals ..... 57
Artificial Intelligence System ..... 70
Graphic Input Workstation ..... 74
Color Graphics Copiers ..... 75
Hard Copy Units ..... 78
Software ..... 67
Display Monitors ..... 81
Computer Graphics Supplies ..... 80

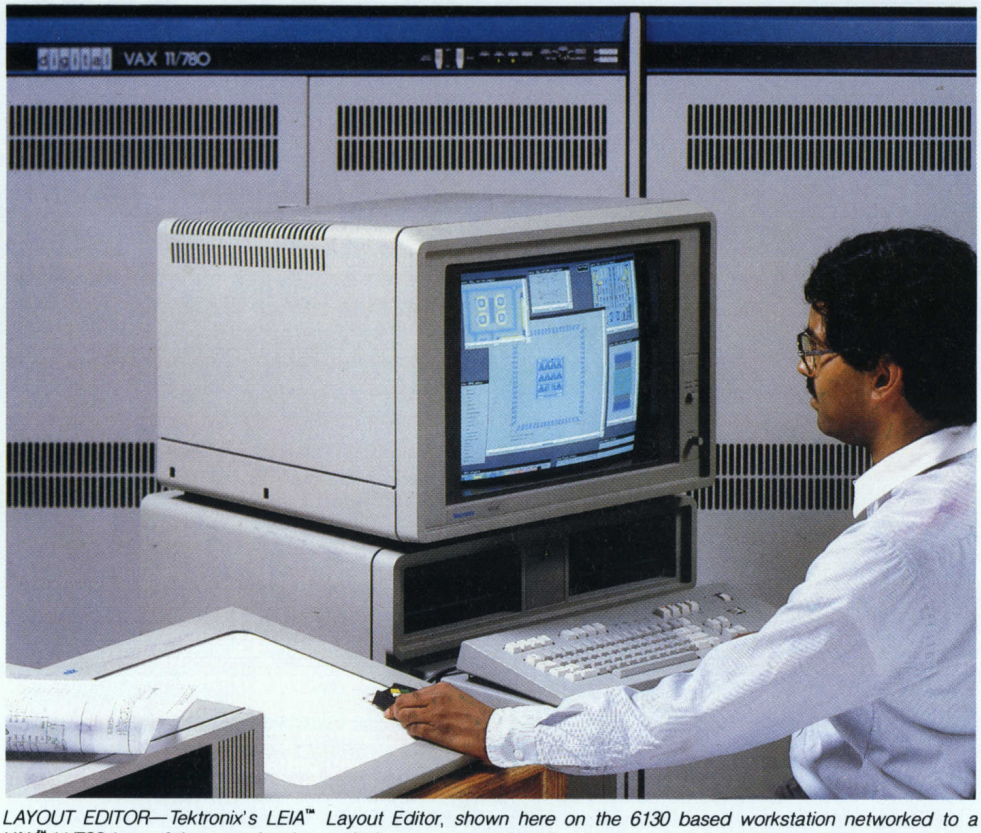
Tektronix sees itself as a company that defines itself not in terms of its products but in terms of its customers. As their needs have expanded — requirements for color, higher speed, local processing, more powerful processing, easier hardware/software integration, more comfortable ergonomic designs — Tek has kept pace by providing state-of-the-art engineering graphic display and computer products at affordable prices.

Tek continues as an industry leader for its product line breadth, its family compatibility, its peripheral support, its use of industry standards and its range of price/performance options. Here are a few examples:

**Computer Display Terminals**
With expanded VT-100 compatible features, copier support and pixel operations standard, the 4100A Series replaces the existing 4100 Series. See page 57.

A noninterlaced raster display which utilizes a precision in-line (PIL) gun CRT with dynamic convergence, the 4120 Series allows crisp display of very fine detail. Choose from either two-dimensional, three-dimensional wireframe, or three-dimensional shaded surface capabilties.

**Artificial Intelligence Systems**
Building on the 4404 AI System, Tek now broadens its AI family to include the 4405 with increased processing power and the high speed 4406.




*LAYOUT EDITOR—Tektronix's LEIA™ Layout Editor, shown here on the 6130 based workstation networked to a VAX™ 11/780 (one of the many hardware platforms supported by the company's electronic design software), provides an environment for engineers to create full custom and semicustom ICs.*

The 1985 Design Automation Conference marked Tektronix's full-scale entry into the CAE marketplace. The level of commitment is demonstrated by the range of integrated products now available through the cooperation of all of the Tektronix operating groups. The acquisition of CAE Systems, Inc., and the recent formation of the CAE Systems Division complements traditional Tektronix strengths and underscores our intention to be a leader in the CAE industry.

### The Demand for Productivity

The most difficult problem faced by electronics manufacturers today is how to get better, more complex products to market more quickly. Computer-Aided Engineering (CAE) technology reduces development time.

Better tools improve the efficiency and accuracy of designs and get a product to market more quickly. The current demand for productivity, coupled with the opportunity offered by computer technology, has led to a new era of engineering. Today, computer assistance is required not just to speed the design process, but, indeed, to make complex projects possible. The state of the art has surpassed the engineer's ability to cope with design complexity without the aid of computers.

CAE workstations speed up the engineering process by allowing the designer to evaluate ideas before committing to expensive prototype fabrication. Many of the detailed design tasks previously performed manually are now done by software. Design errors are eliminated by simulating and verifying the operation of a circuit on the workstation.

### CAE Users Demand More

As CAE tools become available for larger and more complex projects, users are developing new requirements. For example, the need has emerged for an efficient facility for communication and administration of the total design data base.

In the past, emphasis has been on the performance of individual tools. But systems that emphasize individual tools tend to be application-driven. The architecture assumes a defined order in the use of tools and provides for communication only at predefined intersections. It is difficult to provide concurrent access. As products increase in complexity, the need for such access to a single design data base has become critical.

For this reason, the trend is toward "data-driven" CAE tools that view data as the hub of a tool assortment, each with direct access to the entire data base. Under this organization, the CAE environment is seen as a flexible set of compatible tools that may be used in the order and combination appropriate to the specific design task.

### The Next Phase

An important new development in CAE is the movement toward increased integration, better and more consistent user interfaces, and standardized data interfaces among tools. The focus is shifting from the performance of individual workstations and application programs to the effectiveness of the overall design process. Users are demanding new CAE tools that are compatible with existing hardware and software resources and that provide links to existing design, manufacturing, and test tools.

### Tektronix and CAE

Tektronix' entry into the CAE market extends the company's commitment to providing the best available engineering tools. The broadened product line includes leading-edge CAE tools. These products provide Tektronix with the ability to couple state-of-the-art instrumentation to the CAE design process.

Tektronix, the long-standing leader in the verification and test areas of the product development cycle, expanded our technology base to include front-end CAE design tools through CAE Systems Division, headquartered in Santa Clara, California. Development and support centers are located in Boston, Massachusetts; Austin, Texas; Portland, Oregon; and London, England. Thus, Tektronix extends the utility of CAE by integrating hardware design tools with software development, including integration tools, instrumentation, production test systems, and mechanical CAD capabilities.

**Open Systems.** Tektronix CAE Systems Divisions design and test solutions are based on an "open systems" philosophy that combines a wide range of functionality with standard interfaces to fit into existing

design environments. To promote compatibility among tools, the Division actively supports industry-wide standards in the design of its products and through participation in industry standards efforts. Compatible interfaces allow users to configure the engineering environment, broaden equipment and applications software choices, and protect a substantial CAE investment against obsolescence.

**Multiple Hardware Platforms.** Tektronix' CAE tools are available on a variety of computer systems and workstations. Users have a broad choice of hardware platforms including the TekStation™ AT, Apollo workstations, and Digital's VAX family of products ranging from the MicroVAX™ II-based workstations to the powerful 8600. The TekStation AT expands an IBM Personal Computer AT into a powerful engineering workstation that can run both PC-DOS and virtual Unix-based 4.2 BSD software.

The multiple-hardware-platforms approach is an integral part of the Tektronix long-term strategy and will remain an important advantage of Tektronix solutions. Such broad hardware support is critical to users with a large investment in computing equipment and also to users who need extra freedom to choose an optimum configuration. Evolving and improving CAE tools must be able to fit into an existing environment gracefully. Multiple hardware platforms complement the open-systems philosophy by providing the greatest number of options to CAE users.

**Team Engineering.** To work efficiently, engineering teams must be able to work in parallel, which requires good communications on all levels. Tektronix CAE tools are built around the distributed base concept, which gives every engineer instant access to the latest design information. With both hierarchical and relational capabilities, the data base manager allows distributed access to circuit design at several levels of abstraction and in multiple representations. The Tektronix design environment also provides facilities for networking and documentation, and will soon provide full project data management and project tracking capabilities.

**Instrumentation.** Tektronix instrumentation continues to lead the industry in performance and reliability, and we are firmly committed to the pursuit of advanced measurement technology. Many Tektronix instruments already possess the intelligence to perform either in stand-alone mode or as a subsystem in a larger CAE environment. A major Tektronix objective is to extend the available linkages among instruments and systems, allowing the user to select the level of integration appropriate for a particular task.

**The Tektronix CAE Solution**

Tektronix thus offers a comprehensive set of tools for electronic product design and test through integrating products from CAE Systems Division with traditional Tek test and measurement and software development products. To understand how the full complement of Tektronix CAE tools work together in the design engineering environment, consider what is required to implement a complex electronic product containing standard devices, special-purpose ICs, microprocessors, and custom firmware. The Tektronix CAE product line addresses each of the following points in the total design process.

**System Definition.** To aid in overall system definition and requirements specifications, Structured Analysis (SA) tools provide a structured, graphic approach to high-level architectural specifications, for both software and hardware, using data flow diagrams, data dictionaries, and mini-specifications. SA tools allow the designer to specify and analyze what a system will do before dealing with implementation details, and provide a convenient, interactive graphics interface that automated most of the clerical chores associated with creating consistent specifications.

**Software Development.** The LANguage Development System (LANDS) provides a complete development tool kit for popular languages and target processors. LANDS automates the software development process with language-directed editors that check for syntax errors and eliminate many time consuming mistakes that would otherwise be present at compile time. Symbolic debuggers (CDB) allow the software engineer to follow program execution using high level symbolic names and control structures. The Integration Control System (ICS) automates the process of configuring software for a specific hardware environment. The 8540 Microcomputer Integration Unit provides a simulated execution environment with memory and I/O in addition to the target processor.

**Electrical Hardware Design.**

- A concurrent, multi-engineer design environment with a flexible, hierarchical, distributed data base.
- Multiple design representation at each level of the design hierarchy with user-defined block diagram, logic, and circuit descriptions.
- Interactive "what-if" analysis of designs.
- One-button interfaces to industry standard CAE tools running locally or on host computers.
- Capability for easy user interface with in-house tools.
- A LAN with electronic mail to allow multi-engineer communication and data transfer.

The MultiSim™ family of simulator products includes an interactive, 12-state, multi-level logic simulator. MultiSim provides function simulation, timing verification, and an interactive software logic analyzer for probing and waveform display during simulation.

The Functional Modeling Language (FML) option, a part of MultiSim, allows the user to build functional models of selected portions of a system to describe and simulate a design before all of the circuit details are known. The behavioral model can be incorporated as part of an overall simulation that also includes logic and circuit descriptions.

The Testability Measurement Analyzer (TMA) and Statistical Fault Analyzer (SFA) allow the designer to simulate faults, assess the testability of proposed PCBs or ICs, and measure the fault coverage of test patterns before the design leaves the workstation.

Tektronix electronic design system includes the DCALC engineering spreadsheet for "what-if" design analysis, and the LIDS library tools to accelerate the creation and maintenance of component libraries.

To speed analysis of complex designs, the Tektronix electronic design system interfaces to the Zycad hardware logic simulator to execute simulations at more than one million events per second. For simulation of complex components without software models, the TurboChip hardware modeling system allows an IC or PCB to be coupled with a simulation on the workstation to evaluate the combined system. Even software can be factored into the simulation. Code developed in the LANDS environment on a mainframe or an 8560 multi-user development system can be downloaded with MicroLink interface software to the TurboChip hardware modeler containing the target processor and memory. TurboChip then executes the prototype code and interacts with simulated special-purpose hardware on the Designer's Data Base and Schematic Capture System. This allows the hardware engineer to drive the design with software code before the actual hardware is implemented.

Physical design is aided by the MERLYN-PCB package for board layout or MERLYN-G for gate array layout. Performing both interactive and automatic placement and routing, and design rule checking, CALMA GDS/II files are automatically generated for IC mask fabrication.

For custom ICs, Tektronix offers its structured Custom WorkSystem, which includes:

- Module generation by the Tektronix CONCORDE Chip Compiler.
- Layout editing with the Tektronix custom layout editor (LEIA).
- Layout verification by ECAD's Dracula II.

Tektronix electronic design system software provides interfaces to other popular layout programs such as:

- MEDS, GARDS, CAL-MP, and BOLT for IC layout.
- SCICARDS, CALAY, and REDAC for PCB layout.

A comprehensive, up-to-date library system is essential for rapid design implementation. Through the CONNECTIONS joint marketing program, Tektronix has partnerships with selected IC vendors to provide the widest possible range of foundry libraries.

**Verification and Test.** ICs and PCBs can be verified at the engineer's bench with the DAS 9100 Digital Analysis System, which provides test pattern excitation from dc to 50 MHz. DASLink software allows automatically generated test patterns to be downloaded to the DAS from a Designer's Data Base and Schematic Capture System. The acquired results are returned for direct comparison with simulation by displaying actual data through the virtual logic analyzer "roving probe" interface on the workstation.

**System Integration.** One of the most difficult tasks in product development is integrating individual subsystems into a complete system, especially when hardware and software are brought together for the first time. The Digital Design Lab (DDL) combines the 8562 Software Development System or a VAX computer, the 8540 Emulation Control Unit, and the DAS 9100 into a single, powerful integration tool. Using the DDL's high-level debugger, the software engineer can quickly locate trouble areas in the program execution sequence. The DDL can then focus on the area of interest, providing a single, time-aligned display of both instruction execution and hardware logic test points. The hardware logic timing and software execution are made explicit on a single display to locate difficult system integration bugs.

**Mechanical Design.** Tektronix CAE solutions include software products that aid in the mechanical design of enclosures, chassis, card cages, PCBs, and other component packaging. The TekniCAD computer-aided drafting package aids the development and maintenance of two dimensional assembly drawings and general drafting chores. For more complex mechanical tasks, the leading mechanical design and analysis applications programs are available through the Tektronix Solution Vendor program:

- ANVIL-4000 for CAD design, drafting, and manufacturing interface.
- ANSYS for finite element analysis and modeling.
- MCS/GRASP for interface to MCS/NASTRAN.
- SRDC I-DEAS for 3D solids modeling and analysis.
- PATRAN for 3D solids modeling and finite element analysis.

**Documentation.** As products increase in complexity and development cycles become shorter, the need to properly document a design becomes acute. Documentation is a valuable resource that allows engineers to reuse designs and also aids in manufacturing, value engineering, and product customization. The Tektronix CAE electronic design system incorporates the powerful, screen-oriented TekWriter publications software for engineering documentation. TekWriter allows descriptive text to be entered and formatted at the workstation and combined with waveform graphics and tabular information generated by other CAE tools.

### The Tektronix Difference

Tektronix CAE tools span the product development process from concept through production and provide both flexibility in design style and compatibility with the existing environment. A common design data base integrates these tools into an effective data-driven, team-oriented engineering environment. Since Tektronix offers proven test and measurement capability coupled with front-end design, users can incorporate state-of-the-art instrumentation while realizing the benefits of control and analysis through the consistent CAE workstation interface.

Tektronix internal resources provide a large degree of vertical integration, which enables cost reduction and performance advances. The Electronic and Mechanical Component Group maintains eight state-of-the-art engineering and manufacturing facilities for custom silicon and gallium arsenide integrated circuits, analog and analog/digital hybrids, and high-density PCBs. Major in-house software efforts often yield new software development tools to enhance the productivity of all Tektronix product development groups.

Since Tektronix is a major component and system manufacturer, it is a model for evaluating the evolving CAE environment. Internal programs exist to make Tektronix CAE products available to all engineers and to promote rapid feedback to the product development groups. Tektronix believes that the same process of internal evaluation that has made Tektronix oscilloscopes and other instrumentation unsurpassed in the industry can also be applied to CAE tools. Tektronix calls it the "next bench effect"—a product designed by one engineer is likely to be used by the engineer at the next bench.

Tektronix's large R&D resources will prove increasingly important as the frontiers of CAE move into areas such as artificial intelligence, computer-aided software engineering, and high-speed signal processing. For example, instrumentation is currently reaching the limits afforded by silicon technology. Further advances in speed will require more exotic materials such as gallium arsenide (GaAs)—an eventuality anticipated by Tektronix in advanced research that has resulted in state-of-the-art GaAs design and foundry capability.

Tektronix has a large base of traditional engineering customers. This provides knowledge of and direct contact with CAE users of the future. A worldwide sales and service organization and a reputation for quality products and responsive support give Tektronix a credible presence in the evolving CAE market.

### Summary

Computer-aided engineering is based on more than a single turnkey solution. It is a systems integration approach to maximizing engineering productivity by applying computer power. It is a set of flexible, evolutionary solutions that will continue to expand in many dimensions.

Tektronix is one of the first Fortune 500 companies with a comprehensive set of CAE solutions. Users now have a large, reliable vendor source for a broad range of CAE products. Tektronix is establishing the trend toward an open-systems architecture, industry standards, and a flexible tool kit approach to CAE.

Data management is becoming a dominant issue for CAE users. Tektronix's electronic design environment will set the direction for future CAE data base systems. It provides a new level of system integration that includes hardware, software, test and measurement, and project management coupled through a global design data base.

# The WorkSystems

The WorkSystems, designed by Tektronix CAE Systems Division, integrate a complete family of electronic design and test tools with a distributed designer's data base.

Each WorkSystem is a vertically integrated set of computer-aided engineering tools and addresses a specific area of a design cycle, or can be combined to do multiple tasks. The WorkSystem family is comprised of the following:

Designer's WorkSystem
Gate Array WorkSystem
Full Custom WorkSystem
Structured Custom WorkSystem
Standard Cell WorkSystem
PCB WorkSystem
Test and Measurement Worksystem
Software Development WorkSystem

Together, the WorkSystems give you all the tools for your entire development process, including design capture, documentation, verification, test and measurement, PCB and IC layout, and production test.

All WorkSystems feature open architecture so that new tools may be added. Each WorkSystem also works with DEC VAXs™, TekStation AT*, Apollo workstations, and the Tektronix 6000 Family of workstations.

# The Designer's WorkSystem™

**Designer's Data Base Schematic Capture System (DDSC) — Complete Environment for Capturing and Managing Designs**

**MultiSim™ Family: IDEAL™ Simulator, Functional Modeling Language (FML™), Interactive Logic Analyzer (ILA™), Statistical Fault Analyzer (SFA™), Testability Measure Analyzer (TMA™), TurboChip™ (Hardware Modeling)**

**SPICE Analog Simulator**

**Hilo™ Software for Logic and Fault Simulation of Standard Parts, Microprocessors and Custom ICs**

**Libraries: Standard Parts**

**Librarian System for Modifying or Augmenting Existing Libraries**

**TekWriter™ Engineering Documentation and Publication Software**

Integrating design capture and verification tools with a data base, this WorkSystem is a complete environment for conceptual design and analysis.

The Designer's WorkSystem helps you find simple answers to difficult problems by integrating design capture and verification tools. You can even test ideas while they're still only ideas with the MultiSim™ simulator family.

** For full custom and structured custom WorkSystems.*

*MultiSim™ AND ELECTRONIC DESIGN — Designed to support a variety of hardware platforms, Tektronix electronic design software is shown here on an Apollo 660 workstation networked to a VAX 11/780 super minicomputer. MultiSim, a family of logic simulator products and test analysis and verification tools, integrates the design environment with the test and measurement environments.*

### Designer's Data Base and Schematic Capture

The Designer's Data Base and Schematic Capture system offers a completely integrated, hierarchically structured software system for the design of complex electronic circuits. The software runs in a Unix™ or UTek* environment.

Design information in the data base can be defined and accessed along two dimensions. Vertically, the user defines hierarchical levels from the most general and abstract (the functional level) to the most detailed (gate or transistor level). Horizontally, design at each level may appear as a behavioral description, in logical symbols, or as a circuit diagram. A one-button "push" command brings any level into view on the screen. The vertical hierarchy permits review and analysis to focus on details such as fanout and loading, when appropriate. Horizontally, the hierarchical structure encourages "what-if" and trade-off analysis.

The critical difference in the Tektronix designer's data base and schematic capture software lies in the nature and design of the data base. This proprietary, hierarchically organized data base allows the designer to work in his most comfortable style, at any level from top-down to bottom-up, or in any combination. In the same design, and engineer may define and display some blocks at the functional level, others at the logic level, and others at the circuit level. Since the user defines his own hierarchy, existing design practices need not be altered.

With the Tektronix WorkSystems, concurrent design is at your fingertips. Teams of engineers can work simultaneously on different levels. All team members have access to the entire design as it progresses. Because data entered at any design level instantly updates the data base, communication among team members is automatic. Analysis and simulation results are available to all team members. The project manager can view the progress of the entire team and check interfaces for compatibility and compliance with specifications. No copying of files or other special integration procedures are required—the design is always integrated. This total concurrent Team Engineering concept is unique to the Division. In addition, the networked data base is integrated with other tools within the WorkSystems to protect your design data investment.

### TekWriter™

TekWriter Publications Software is based on Interleaf's Workstation Publishing Software™ for engineering documentation.

Design graphics and text can be mixed within documents. TekWriter allows engineers to accelerate, improve and simplify the development of documentation associated with the design of integrated circuits and printed circuit boards.

TekWriter also enables the user to edit and format documents, as well as illustrate production quality technical publications. Users can select from various type faces and sizes.

*VAXstation II — Using Tektronix's electronic design software, DEC's VAXstation™ II engineering workstation is one of the most powerful and flexible systems available.*

**MultiSim***

ILA is used to create, compare and display waveform simulation data, as well as data derived from test and measurement equipment.

MultiSim is an integrated, modular family of design simulation and verification software tools.

The MultiSim family is composed of the following:

- A choice of different modeling methods:
  - functional (FML)
  - physical modeling (TurboChip*)
  - C modeling
  - functional (gate and switch level modeling)
- IDEAL Logic Simulator (12-state, interactive multilevel simulation kernel).
- Statistical Fault Analyzer (SFA™)—for fault simulation. Engineers doing combinatorial or sequential circuits can quickly analyze the accuracy of their test patterns.
- Interfaces to Tektronix's standard Microcomputer Development Products (MicroLink™) and Design Automation Systems (DASLink™).

**Logic Libraries**

To reduce design time, Tektronix offers access to a library of over 3000 standard parts, including those for TTL. FAST, CMOS, ECL, and MICRP-P.

Systems and IC designers have a wide variety of state-of-the-art implementations for their electrical designs. The libraries provide primitive elements from simple gates to complex functions such as I/O buffers, multiplexers and memories.

** Test and Measurement WorkSystem*

## Gate Array WorkSystem

**MERLYN-G™ Automatic Gate Array Placement and Routing System**

**Libraries: Foundry, Logical, and Physical Gate Array Libraries**

**DDSC**

**MultiSim Family**

Offering complete electrical and physical design system for gate array VLSI layout, verification and analysis, the Gate Array WorkSystem also provides 100 percent fully automated placement and routing, as well as access to extensive parts libraries.

The Gate Array WorkSystem from Tektronix brings all the power of the Designer's WorkSystem plus the proven Merlyn-G gate array layout tools. Modules are included within the WorkSystem to provide the user with automatic place and route. Logic Libraries are also part of the Gate Array WorkSystem.

## Full Custom WorkSystem

**LEIA™ Interactive Layout Editor for Custom ICs**

**Dracula II Layout Verifier**

**DDSC**

**MultiSim Family**

This WorkSystem provides full custom chip design including design capture, simulation and an interactive full custom layout editor.

In addition to the full Designer's WorkSystem features, the Tektronix Full Custom WorkSystem includes LEIA* layout editor, which allows IC designers to create layouts for custom and semicustom ICs. LEIA is also Calma GDS II STREAM compatible, and interfaces with the Dracula II layout software.

Dracula II, from ECAD, Inc. of Santa Clara, California, provides users with a tool to verify the accuracy of integrated circuit layout data. The program includes a design rule checker, electrical rule checker, layout parameter extractor (LPE), layout schematic and layout versus layout comparators, interactive post processor of LPE data base and a Versatec plotter interface.

** For full custom and structured custom WorkSystems.*

## Structured Custom WorkSystem

**Concorde Chip Compiler**

**DDSC**

**MultiSim Family**

Coupled with Designer's WorkSystem, complete electrical and physical design capture, verification and layout is provided for structured custom ICs. The Concorde™ Chip Compiler is fully integrated with the data base and MultiSim family.

The Structured Custom WorkSystem combines all the features of the Designer's WorkSystem along with the Concorde Chip Compiler. Logic Libraries complete the structured custom design system.

Concorde manages and simplifies digital design, geometry generation, placement, routing and packaging. This gives electrical engineers who are not IC design specialists the ability to develop their own application-specific chips.

## Standard Cell WorkSystem

**MERLYN-S™ Standard Cell Layout System**

This WorkSystem offers complete design capture, simulation and layout, with foundry supported cell libraries for standard cell ICs.

## PCB WorkSystem

**MERLYN-PCB™ Automatic PCB Design System**

**Foundry, Logical and Physical Standard Parts Libraries**

**DDSC**

**MultiSim Family**

Board-level design capture, verification and layout, as well as extensive parts libraries, are included in this WorkSystem.

The PCB WorkSystem combines the features of the Designer's WorkSystem along with the powerful features of the Merlyn-PCB automated printed circuit design system, and Parts Library.

*MicroLink™ FOR MICROCODE DEVELOPMENT — Tektronix's MicroLink provides an interface between the electronic design environment and the company's Microcomputer Development Systems. Using MicroLink, microcode can be developed on the TekStation™ and then tested using the Tek 8540 emulator and associated IC probe shown here.*

## Test and Measurement WorkSystem™

**DASLink™ Interface to Tek DAS 9100 Logic Analyzers**

In conjunction with Designer's WorkSystem, this WorkSystem compares real and prototype hardware with conceptual designs.

The Test and Measurement WorkSystem combines the features of Designer's WorkSystem along with the ILA (Interactive Logic Analyzer), DASLink interface to the Tektronix DAS 9100, and MicroLink interface to Software Development Products.

DASLink is a software module integrating the capabilities of the MultiSim logic simulator family with the Tektronix DAS 9100™ Digital Analysis System. DASLink allows the DAS 9100 to stimulate a device with the same stimulus pattern data used with CAE Systems Division's IDEAL™ logic simulator, part of the MultiSim family.

## Software Development WorkSystem

**MicroLink™ Interface to Software Development Tools for Microprocessor Development**

With the Software Development WorkSystem, development and debug of microprocessor code can be done in parallel with hardware design.

The Software Development WorkSystem includes MicroLink, the Division's interface between SDP standard file format and the computer-aided engineering software. Also included with the WorkSystem is the Utek environment and compilers.

For further information about the WorkSystem products and configurations as they apply to your particular design needs, please contact:

Tektronix
CAE Systems Division
5302 Betsy Ross Drive
Santa Clara, CA 95050
Phone: (408) 727-1234
(800) 547-1512 or (800) 542-1877
Telex: 821378 CAESYSTEMS

# Workstations—The Tek Approach

In the past, Tektronix has supported the needs of scientists and engineers by providing engineering instrumentation, computing controllers, software, and high-quality graphics terminals. Tek expands this support with the 6130—a 32-bit, high performance, multifunction workstation that delivers computing power, with a range of capabilities to handle a full spectrum of scientific and engineering applications.

The 6130 has the configurability and expandability to fit into your current environment and grow as your requirements change. It is designed to make it easy to add hardware capabilities and peripherals, and to develop and transport applications programs. As a result, you can put together exactly the system you need. Or, you can choose from several preconfigured Application Systems described at the right.

**Flexible Interfacing**
A workstation needs to fit into your existing environment. For maximum flexibility in interfacing, the 6130 provides RS-232, high-speed serial and parallel ports. Also supported is a Centronics-compatible hardcopy interface. IEEE Standard 488 General Purpose Interface Bus (GPIB), and high-speed buses. The 6130 also supports the Small Computer System Interface (SCSI), an auxiliary mass storage interface, and IBM PC compatible flexible disk format.

Terminal emulation is available as well, enabling the workstation to function as a terminal-to-host computer. Terminal emulation combines with the display's windowing capability, so that you can open a terminal emulation window to a host while simultaneously executing application programs through other windows.

Workstations can be interconnected to a Local Area Network (LAN) based on the IEEE-802.3 standard, using the TCP/IP protocol. The LAN can also be used for communications with VAX computers running compatible versions of UNIX or VMS. Supporting software handles communication services such as the ability to log in to a remote workstation and transfer files between workstations. A distributed file system is also provided. In addition, the Tektronix operating system, based on UNIX, includes an electronic mail utility that provides user-to-user communications. An optional, fully relational database management system facilitates data sharing among workstations. The LAN also allows workstations to share the use of peripherals.

# *NEW* Graphics Application Systems

Tektronix's *NEW* Family of Application Systems saves you configuration hassles. We identify the right hardware and software mix for the defined application areas. Then we integrate and test the equipment at the factory and ship you a preconfigured system tailored to your specific needs.

Our application systems are based on years of experience at providing graphics tools to technical and scientific users. They're selected from our broad product lines of computing and graphics hardware and software.

The Tektronix 6130 workstation with its UNIX-based operating system, standard interfaces, and multi-user environment provide the framework for these systems. Color graphics terminals are chosen from Tek's spectrum of price/performance options. A variety of graphics hard copy devices, including printers, plotters and color copiers, are also available. Finally, we've selected software that answers the needs of each individual application.

Since our family of Application Systems is based on Tek products, you can be assured that the hardware and software are designed to industry standards. When the products are compatible, the systems are expandable. They offer you a growth path. And your investment is backed by the best training and service organization in the industry.

**Drafting Systems**
Our Drafting Application Systems combine the processing power needed for responsive and demanding graphics, high-performance graphics terminals, a graphics tablet for input, a plotter for output and PLOT 10® TekniCAD, a versatile, drafting software tool. See page 61.

**Technical Data Analysis and Presentation Systems**
Technical Data Analysis (TDA) has another set of criteria. Computing and graphic requirements are less demanding. But there is a need for additional software to enable users to analyze data and prepare professional presentations.

Technical Data Analysis Systems meet your performance criteria. In addition, you can use the TBASIC language to run your existing Tek 4050 programs in this new environment with a minimum of changes. See page 56.

**UNIX-Based Software Development System**
Software developers require still more performance and memory for editing and compiling large programs. Special programming utilities, standard languages and the ability to easily port programs to other systems are their primary needs. Computer graphics here are used more frequently to interface with the system than to draw pictures. For software development, we've configured a powerful system that includes the development tools a programmer needs to do the job effectively. See page 54.

## 6130 Intelligent Graphics Workstation

GPIB IEEE-488

The 6130 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**UNIX-Based Operating System**

**Integrated Local Area Network**

**4000 Family Terminal Support**

The 6130 Intelligent Graphics Workstation is a powerful workstation designed around the UNIX-based UTek Operating System. The workstation supports color graphics, extended I/O and peripheral interface capabilities, extensive mass storage and networking functions. These expandable, low-cost 32-bit workstations are designed for applications such as data analysis, software development, schematic entry, and computer-aided engineering.

The 6130 workstation features include up to 80 MB internal storage capacity, and compatibility with all 4000 Family terminals. The 6130 also features the UTek Operating System with C, FORTRAN, ISO Pascal and ANSI BASIC programming support. Interactive graphics are available through the PLOT 10 library of routines which include the Terminal Control System (TCS), Interactive Graphics Library (CORE standard) and the Software Terminal Interface.

A wide range of options and enhancements allow a user to configure the system. Display options include monochrome, color raster or DVST. A range of graphics processing power is also available. In addition, the 6130 is an integral part of our family of Application Systems, beginning on page 50.

### NS32000-Based Compute Power

National Semiconductor's Series NS32000 microprocessors feature *mainframe on a chip* architecture, an instruction set designed for efficient execution of high-level-language programs, and a separate memory management unit for supporting virtual memory. The 6130 architecture is based on a single CPU and a local bus. The processor is the NS32016, with a 16-bit data path and 32-bit registers. The NS32016 supports UNIX and high-level language processing.

Additional processors for specialized functions, such as high-speed I/O, are attached to the local bus. Augmenting the 32016 CPU are a 32-bit floating point processor and a 32-bit memory-management unit. These chip subsystems relieve the central CPU of specialized processing-intensive chores and ensure maximum system-wide throughput.

### UNIX-Based Operating System

The 6130 Intelligent Graphics Workstation supports an extremely powerful version of the UNIX operating system (based on Berkeley 4.2, with many System V extension enhancements). Tektronix's implementation of UNIX (UTek) has many useful features such as electronic mail, network support, line and screen editors and remote login. Also included are an expanded set of utilities and a high-performance virtual memory implementation.

A broad range of personal productivity software and high-level-language support for application development is available for the 6130 Intelligent Graphics Workstation.

### A Computing Strategy

In selecting workstations, you look for systems that support a range of computing and display requirements, which allow you to utilize your existing investment in computing hardware and software, and can continue to grow as your requirements change. The 6130 Workstation meets those needs. As a *value-added* they have Tektronix' graphics experience and service/support organizations behind them. The 6130 gives you not just a workstation but the *core of a computing strategy.*

## CHARACTERISTICS

### PERFORMANCE

**Computer Engine/Memory**

**Processors** — NS32016, NS32081 Floating Point Processor.

**On-Board Memory** — 1 MB (2, 4, or 6 additional MBs optional).

**Access Method** — Demand-paged virtual memory.

### I/O SUBSYSTEM INTERFACE PORTS

**Standard:**

**Dual RS-232-C**

Data Rate — 110 baud to 19.2 kbaud with flagging

**IEEE 488 GPIB**

**LAN 802.3**

Protocol — TCP/IP

**Optional:**

High Speed GPIB

Dual, High Speed RS-232 (38.4 k band with flagging)

Dual Centronics

Small Computer Standard Interface

Sync/Async High Speed RS-232-C/RS-422

### PHYSICAL CHARACTERISTICS

### SYSTEM CABINET

| Dimensions | mm | in |
|---|---|---|
| Width | 427.7 | 16.84 |
| Height | 154.9 | 6.1 |
| Depth | 607.0 | 23.9 |
| **Weight** | **kg** | **lb** |
| Net | 9.1 | 20.0 |

### OTHER CHARACTERISTICS

**Line Voltage Ranges** — 87 V ac to 132 V ac (115 V ac nom); 174 V ac to 264 V ac (230 V ac nom).

**Line Frequency** — 48 Hz to 66 Hz.

**Power** — 445 W max (including 200 W for accessory outlet).

**Safety** — Conforms to UL 478, CSA 154, IEC 435.

## ORDERING INFORMATION

**6130** Intelligent Graphics Workstation **$9,500**

**OPTIONS**

**Option 2A** — 2 MB Memory Board.

**Option 2B** — 4 MB Memory Board.

**Option 2C** — 6 MB Memory Expansion.

**Option 3A** — Dual RS-232-C Data Communications Interface.

**Option 3B** — Dual Hardcopy Interface.

**Option 3C** — Sync/Async Data Communications Interface.

**Option 3D** — High Speed IEEE 488 GPIB Interface.

**Option 3E** — Network Adapter, Ethernet.

**Option 14** — Substitute 40 MB Hard Disk Drive.

**Option 15** — Substitute 80 MB Hard Disk Drive.

**Option 40** — 40 MB Tape Cartridge Expansion Unit.

**Option 41** — 40 MB Mass Storage plus 40 MB Tape Expansion Unit.

**Option 42** — 80 MB Mass Storage plus 40 MB Tape Expansion Unit.

*Note: Price information available after November 1, 1985*

***WARRANTY-PLUS* SERVICE PLANS**

**SEE PAGE 457**

**N1** — On-site Service Plan +9 months upon warranty expiration. **+$585**

**N3** — OEM On-site Service Plan +12 months (transferable). **+$780**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220V/16A.

**Option A2** — UK 240V/13A.

**Option A3** — Australian 240V/10A.

**Option A4** — North American 240V/15A.

**Option A5** — Switzerland 230V/16A.



**Flexible leasing programs available in the continental U.S.**

## LOCAL AREA NETWORK

The Tektronix Local Area Network (LAN) is a high-bandwidth communication facility used to interconnect a 6130 Workstation with various peripheral devices. The LAN is supported with UTek Operating System software. 6130-LAN features include: a distributed file system (virtual files), remote login and execution (virtual terminal), and high-speed bidirectional file transfer.

Because the LAN is a nonproprietary network, no system training or unique LAN programming is required to use it. The LAN's use of VLSI technology makes the 6130 Workstation cost effective and easy to maintain.

The LAN provides multi-layered services at all levels of the International Standards Organization/Open Systems Interconnection reference model. UTek based utilities provide *remote* commands allowing users to get work done on other 6130 Workstations on the LAN. UTek utilities also have the ability to copy files to and from remote nodes (rcp), to login to a remote node (rlogin), to execute a process on another node (rsh), and to send mail.

Higher level application services also include File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP), and Virtual Transfer (Telnet)—all compatible with the Department of Defense protocols.

Transmission Control Protocol/Internet Protocol (TCP/IP) handles communications between a user program and other processes executing at the same workstation, at a different workstation on the LAN or on a different network.

### Configuration Flexibility

Networks may be composed of virtually limitless combinations of 6130s and compatible systems. For applications emphasizing communications and selective file transfer, workstations can be configured with peripherals and high-capacity disk or tape drives. In other applications, workstations can be configured with more basic, local resources. Workstations rely on the network for access to high-capacity print/file server nodes.

**Data Transmission.** Data is transmitted serially over the LAN at a maximum rate of 10 Mbit per second. Access to the network cable is through a Carrier Sense Multiple Access with Collision Detect (CSMA/CD) technique. If two nodes attempt to transmit data at the same time, the collision-detect circuitry senses the conflict, allowing the nodes to rebroadcast without collision. This results in an extremely low collision rate (statistically) even in high traffic environments.

**LAN Administration.** The LAN configuration utility permits fast, easy integration of a workstation into the network. Also standard are utilities to assist in monitoring/controlling the network, such as traffic indicators and commands to display the status of each network node (connections and protocols in use). For security, users can specify read, write, and execute permission over the LAN. Remote administrative functions handle file system maintenance and configuration management as well as user/node/group identifications.

## PERIPHERALS

The 6130 Intelligent Graphics Workstation includes several peripheral support units that can be linked via Local Area Network (LAN). This interconnection gives all users on the LAN access to all peripherals. Mass storage devices, such as the 61TC01 Cartridge Tape Drive, expand the amount of on-line data storage available and provide for convenient archiving and back-up files. 6130 workstations support various types of peripheral access. Peripheral devices can be dedicated to a single workstation, shared among workstations on the LAN, or a workstation can be configured as a peripheral/file service node that can be accessed by all other workstations on the network.

The 6000 Family peripherals interact with the workstations through a variety of interfaces. Equipment interface ports for the 6130 include: RS-232-C, RS-422, GPIB, and SCSI.

### 61TC01 Cartridge Tape Drive

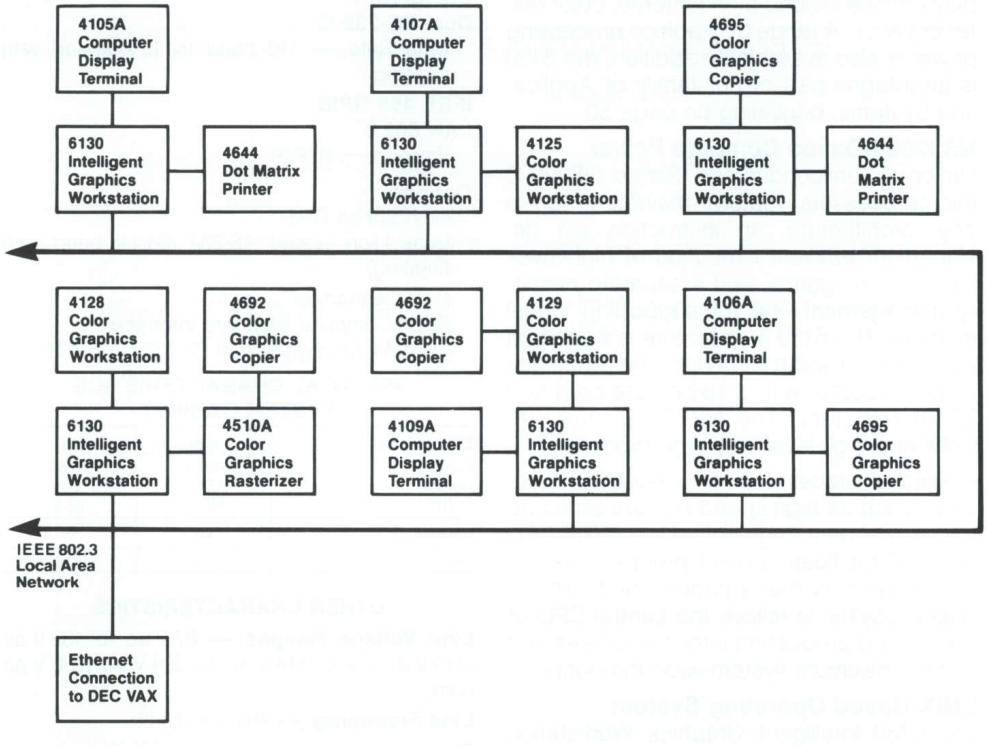
The 61TC01 is a removable, streaming media backup system for the 6130 Workstation. It features streaming or start/stop operation, quick data retrieval or backup, removable 45 MB or 60 MB tape cartridge, and standard SCSI interface. Data transfer rate is 86.7 kB per second at 90 ips. 61TC01 is part of Option 40, Option 41, and Option 42.

### 4644 Dot Matrix Printer

The 4644 provides high-speed draft printing at 160 characters per second or *near-letter-quality* printing at 27 characters per second. It features dot addressable graphics and seven international character sets, in addition to U.S. ASCII. A 17-inch wide platen is standard.

### 4695 Color Graphics Copier

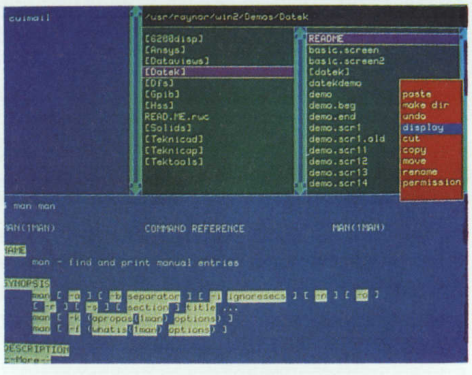
The 4695 provides high-quality, color hard copies of workstation displays. It uses a unique drop-on-demand ink-jet technology to provide addressability of 120 dots per inch in both horizontal and vertical directions. Inks and paper are carefully matched to give excellent color saturation and brilliance. True black is provided by a separate black ink supply.



## THE SOFTWARE STORY

The 6130 Workstation provides an integrated, state-of-the-art, user interface and a variety of general-purpose software tools that enhance professional productivity. In addition, the porting of software to the workstation is simplified by the extensive use of software standards and by specialized tools that support the tasks of developing applications programs. Software tools play a key role in enhancing professionals' productivity.

The Casual User Interface is a complete operating environment. The user can move within the CUI to use the conventional operating system interface. Application programs developed or acquired may also be added to the CUI.




### UTek—An Enhanced UNIX

- Comprehensive set of reliable utilities
- Improved program development environment
- Systems Administration Interface
- Distributed File System simplifies network operations
- Hybrid utility set supports both System V and Berkeley 4.2 features
- Interactive tutorials
- Improved on line help
- Backed by Tektronix service and support

UTek, the universal system for Tektronix Intelligent Graphics Workstations, is a UNIX-enhanced product that provides a consistent interface across the workstations. Along with the use of one family of processors (National's Series 32000 ), UTek helps ensure that programs developed on one workstation will run on any similarly configured workstation.

UTek provides all the capabilities that have led to UNIX's widespread popularity, including:

- A multi-user, multi-tasking environment
- Hierarchical file and directory organization
- A simple but powerful command language that includes looping and branching capabilities
- A great number of simple utilities that can be combined in a multitude of ways
- Excellent program development tools

In addition, UTek's enhancements provide added-value to programmers and end users alike. These enhancements include:

- A virtual memory implementation that allows the efficient execution of very large programs
- A command set, with extensive bug fixes and enhancements to system utilities
- A Multiple-Device Queueing System that provides sophisticated queueing capabilities not often found on UNIX-based systems.

Another key UTek enhancement is the Distributed File System, which helps you get the maximum possible benefit from being part of a network of workstations linked via LAN. The DFS means that you no longer have to use special commands such as remote login (rlogin) or remote copy (rcp) to access another network node. Instead, you can refer to a file on another network node by simply prefixing the file's regular path name with a double slash and the name of the network node on which the file resides. (The special "remote" commands are still available, for users who prefer them.)

Frequently, several organizations within a company will share the same LAN network; however, they may not want to share the same Distributed File System. With the 6000 Family DFS, multiple distributed file systems can coexist and even overlap.

UTek includes a number of features designed to give you the advantages of UNIX without the disadvantages. To start with, there's an interactive on line tutorial, developed expressly for the Tek Intelligent Graphics Workstation that introduces basic UNIX concepts.

The on-line "manual pages" that describe each system command have been extensively revised, and can now be accessed through an interactive manual page browser. On-line explanations of system error messages are also available.

Even system administration is easier, thanks to an interactive, menu-based program called "sysadmin." Sysadmin provides help with system administration tasks, such as configuring ports, administering the network, creating user accounts, installing software, and maintaining the file system.

In addition, with the 4100 Series and 4115B Computer Display Terminals, and 4120 Series Color Graphics Workstations, the optional Casual User Interface (CUI) creates an alternate, window interface that provides the full power of UTek. With the CUI, you access system functions by using a printing device to select menu items, thus minimizing the need to know about command names and syntax.

UTek is packaged to enable you to make maximum use of your available disk space:

- The core package, which comes standard on the 6130 workstation, contains most standard commands and utilities, including the Distributed File System.
- UTek/A, the Auxiliary Utilities package contains on line documentation, text-processing utilities, the C shell, and miscellaneous utilities.
- UTek/PS, the Programming Support package, contains programming-related libraries and utilities, such as archivers, debuggers, and profiling tools. If you use any of the workstation's compilers, you must also purchase UTek/PS.

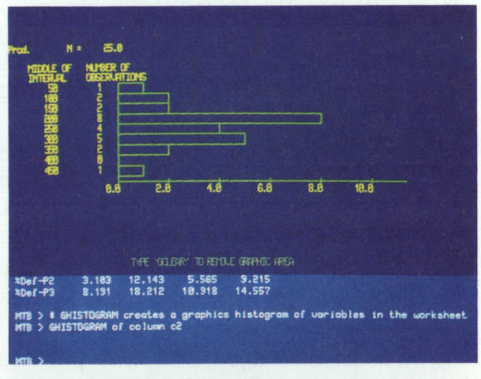
### Minitab Statistical Analysis

This interactive data analysis package for the UTek environment helps you make better decisions by turning data into useful information.

- Comprehensive, easy-to-use data analysis
- Versatile plotting capability
- Cross tabulation
- Fortran-formatted I/O
- Command file capability
- English-language commands, on-line help

Minitab is a general-purpose statistics package that helps you analyze data, then produce graphs and tabular views of the analyzed data.

Capabilities include: Regression analysis with diagnostics, residual analysis and stepwise procedures, Analysis of variance, Nonparametric methods, Times series analysis, and Matrix operations, including eigenanalysis.




### Software Development

To lower the cost of developing and transporting application programs, the 6130 Family uses an open architecture approach and supports a number of software standards.

# TEK WORKSTATION SOFTWARE

Standardization starts with an operating systems based on UNIX, which is becoming a standard among 16-bit and 32-bit systems. A large pool of existing UNIX applications programs can run on the workstations. The Tektronix implementation is based on Berkeley 4.2, with extensions such as demand-paged virtual memory for the efficient execution of very large programs. For languages, the 6130 has high-performance compilers for FORTRAN 77, C, and ISO Pascal. Also supported is the proposed ANSI BASIC, which integrates graphics, program segmentation, file processing and structured programming concepts.

Tektronix PLOT 10 software packages like Graphical Kernel System (GKS), a standard that brings the advantages of device-independent graphics to workstation applications while maintaining high performance. TekniCAD, TCS and IGL are supported on the 6130.

**Relational Data Base Management**

DaTek, a powerful, easy-to-use relational data base management system provides a vital tool for information management. No programming is required. To get information from the data base, you use the IBM-standard SQL query language. Applications programs can use DaTek through C, FORTRAN, and Pascal preprocessors. This system allows the user to keep information in independent files, instead of locking data into specific programs. These are displayed as simple, easy-to-read tables called *relations*. A collection of relations make up a *data base*. Because the data bases are maintained independent of any particular application, different programs can access the same data. This data independence also means you will be able to get answers to questions your programs aren't programmed to ask by using simple, English phrases (through the Query Language). It also allows data bases to be reorganized as changing requirements dictate.

**Data Base Management System Features**

- SQL Query Language—SQL, the IBM standard for Non-Procedural (i.e., not requiring programming) Query Languages, allows the user to ask questions of the data base.
- Report Writer—The Report Writer allows users to quickly define reports to be produced from data in data bases. These definitions can be edited to reflect changing requirements.
- Program Interface—All the facilities of the data base management system are available to any programming language: C, FORTRAN, Pascal, even proposed ANSI BASIC.
- Help Facilities—On-line interactive HELP facilities provide easy access to DaTek documentation.

The data base management system provides a tool for handling the extensive information management needs of today's professionals. It can also be a network resource, allowing users from varied disciplines and locations within a corporation to share data.

## 6130S62

**UNIX Software Development System**

GPIB IEEE-488

The 6130S62 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

The UNIX Software Development System is based on the 6130 Intelligent Graphics Workstation, a powerful 32-bit system with the UTek® Operating System based on UNIX.

The system comes standard with 2 MB of system RAM, a floating point processor, a 360 kB, 5¼ inch flexible disk drive, and an 80 MB, 5¼ inch Winchester disk. Also included are dual RS-232, GPIB and LAN interfaces.

We're offering the 4105A Computer Display Terminal (page 62), featuring a 13-inch screen, 480 x 360 pixel resolution, and a selection of eight colors from a 64-color palette to provide the graphic user interface.

For a hard copy device, the 4644 Dot Matrix Printer handles the routine printing needs of a software development team. It offers a choice of draft printing at 160 cps and near letter quality printing at 27 cps. For graphics output, the 4644 offers high-density, 8-pin, 9-pin, or 16-pin graphics, with six horizontal densities up to 240 dots per inch and three vertical densities up to 216 dots per inch.

We've also bundled development tools. The Auxiliary Utilities package contains the system's on-line documentation as well as test processing utilities, the C shell and other utilities.

The Programming Support package contains programming-related libraries and utilities including archivers, debuggers and profiling tools. Of course, high-performance compilers for C, FORTRAN 77 and ISO Pascal are provided for program development.

As with the rest of Tektronix's Application Systems, the software development workstation is designed to grow with your project. Add users, add processing power, and add software.

### ORDERING INFORMATION

**6130S62** UNIX Software Development System **$18,175**

Complete system description, option listing and pricing are available through your local Tektronix sales office.



**Flexible leasing programs available in the continental U.S.**

## 6130S11
### Single-User Drafting System

The Single-User Drafting System is based on the 6130 Intelligent Graphics Workstation, a low-cost, but powerful 32-bit system with the UTek Operating System based on UNIX. Specifically designed for applications such as drafting, this system comes standard with 1 MB of system RAM, a floating point processor, a 360 kB, 5¼ inch flexible disk drive, and a 40 MB, 5¼ inch Winchester disk. Also included are dual high-speed RS-232, GPIB and LAN interfaces.

Different types of drafting applications demand different levels of graphics performance, so we're offering several optional display terminals.

The 4107A Computer Display Terminal (page 59) features a 13-inch screen, 640 x 480 pixel resolution, and a selection of 16 colors from a 64-color palette. The 4109A offers the same level of performance but has a 19-inch display with 1280 x 1024 resolution. This terminal is also easily expandable to 4128 3D wire-frame and 4129 3D shaded surface graphics.

For the finest detail, the 4125 Color Graphics Workstation (page 66) has a color, 19-inch display with 1280 x 1024 resolution. This terminal is also easily expandable to 4128 3D wire-frame and 4129 3D shaded surface graphics.

The menu-picking device is the 4957 Graphics Tablet (page 79) for use with the 4107A, 4109A or 4125.

For your hard copy needs, we offer an optional Calcomp 1043 plotter with the capability to produce E-size drawings.

Drafters want the power of color graphics without spending hours learning the complexities of an operating system or a new command language to get a program to work. Our application software addresses those requirements.

For example, the Casual User Interface (CUI) lets the user access this powerful computer and the features of the operating system through menu selections instead of cryptic commands.

The drafting software is PLOT 10 TekniCAD, an easy-to-use, versatile program that works the way a drafter works. It also has a menu-driven interface and uses English prompts—again, no foreign commands to learn.

TekniCAD lets you create drawings easily by combining stored images or with free-form input. Special functions let you edit and update your work quickly. You can, for instance, COPY drawings or segments, automatically CHECK the accuracy of your data, and even have the system archive your drawings.

## 6130S12 Two-User Drafting System

Our Two-User Drafting System is also based on the 6130, but adds an optional 80 MB disk and 1 MB of system memory to accommodate an additional user. The same optional displays are available, but the configuration includes two terminals and two graphic tablets. The software offered is the same as for the single-user system.

These systems are designed to meet your requirements today. But we know how fast the picture changes, so we're committed to protecting your investment tomorrow. The Drafting Application systems are compatible with Tektronix 4100 and 4110 Computer Display Terminals and can fit easily into your existing computing environment. You can add additional processing power, peripherals or other application software as your needs dictate.

### ORDERING INFORMATION

**6130S11** Single-User Drafting System **$13,100**

**6130S12** Two-User Drafting System **$18,650**

Complete system descriptions, option listing and pricing are available through your local Tektronix Sales Office.

**Flexible leasing programs available in the continental U.S.**

# TEK PRECONFIGURED WORKSTATION APPLICATION SYSTEMS

## 6130S71
### Technical Data Analysis System

GPIB IEEE-488 The 6130S71 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

The Technical Data Analysis System is based on the 6130 Intelligent Graphics Workstation, a low-cost, powerful 32-bit system with the UTek® Operating System based on UNIX.

The system comes standard with 1 MB of system RAM, a floating point processor, a 360 kB, 5¼ inch flexible disk drive, and a 40 MB, 5¼ inch Winchester disk. Also included are dual RS-232, GPIB and LAN interfaces.

We're offering several optional display terminals to accommodate various graphing needs. The 4105A Computer Display Terminal (page 58) features a 13-inch screen, 480 x 360 pixel resolution, and a selection of eight colors from a 64-color palette. The 4109A offers 640 x 480 pixel resolution with a 19-inch display that is more appropriate for dense graphics. It features 16 colors from a palette of 4096 for greater differentiation of data.

For archival purposes, we've selected the 4695 Color Graphics Copier (page 77), a low-cost, high-performance copier (120 dots per inch) with the capability to produce color copies and transparencies.

Software was chosen to make the analyst's job easier. For example, the Casual User Interface (CUI) lets the user access the features of the operating system through menu selections instead of computer commands.

For those users with 4050 Desktop Computers who want to expand their system capability, we are providing TBASIC. Based on the proposed ANSI standard, it allows you to recompile 4050 BASIC programs with a minimum of changes. TBASIC also offers excellent color graphics and GPIB support.

## 6130S73 Technical Data Analysis and Presentation System

GPIB IEEE-488 The 6130S73 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

Our Technical Data Analysis and Presentation System is also based on the 6130, but adds an optional 80 MB disk to accommodate running more application software. The same optional displays are featured.

Besides the 4695 low-cost color copier, the 4692 Color Graphics Copier (page 76) is also optionally available. With higher resolution (154 dots per inch), this copier produces graphics with precise registration and rich, saturated hues. It also produces transparencies as well as copies. The 4510A Color Graphics Rasterizer (page 76) can be used with the 4692 to further improve the resolution and to expand the color palette to over 274,000 selectable colors.

As with the 6130S71 Technical Data Analysis System, this system also includes TBASIC which allows you to recompile 4050 BASIC programs with a minimum of changes. TBASIC also offers excellent color graphics and GPIB support.

Additional application software for this system includes enhancements to the UTek Operating System and a presentation graphics package.

Special enhancements of UTek let scientists and researchers get up to speed fast and take advantage of the powerful features of the UNIX-based operating system. The Auxiliary Utilities provide on-line documentation for the operating system, as well as text processing utilities.

Another important requirement of many TDA applications is the ability to present the results of the analysis. PLOT 10 TekniCAP software automates the creation and production of color presentation graphics. This menu-driven program lets users create professional-looking graphics quickly and easily.

### Analyze the Results for Yourself

With either of these application solutions, you have the flexibility to expand your system and to add other application software to keep pace with your needs.

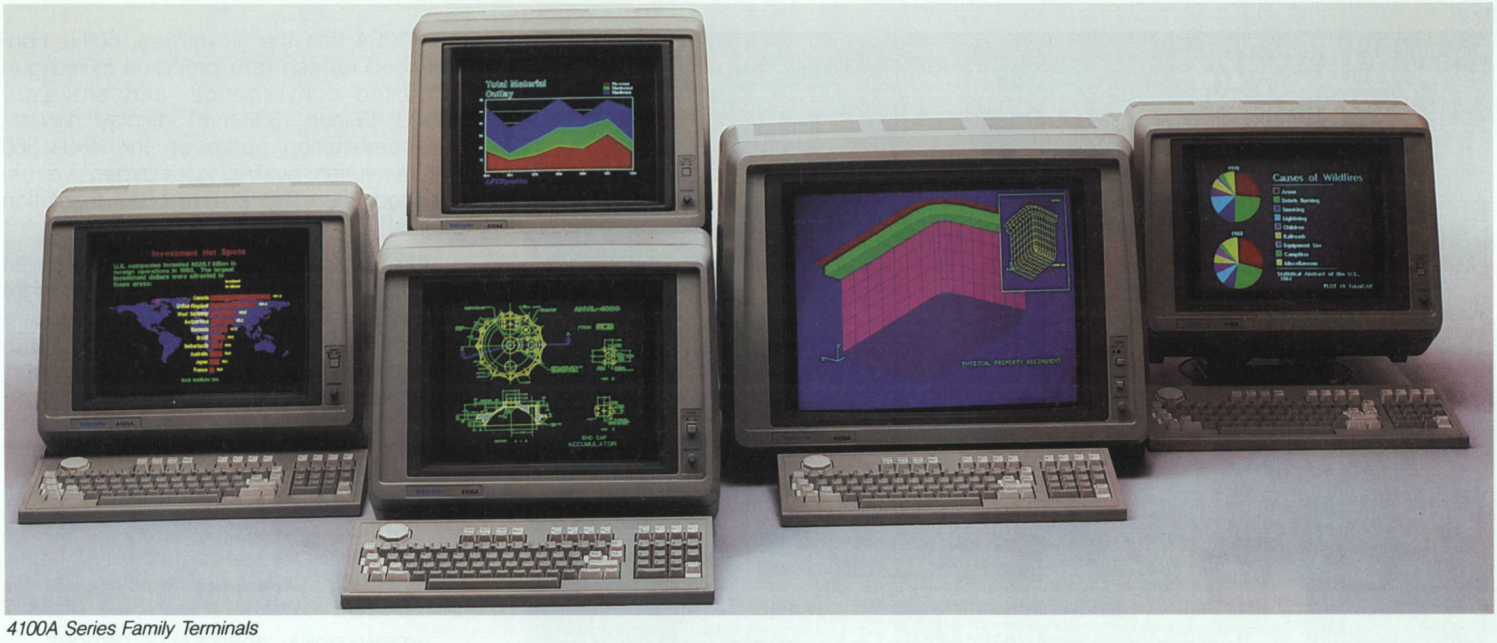
### ORDERING INFORMATION

| | |
|---|---|
| **6130S71** Technical Data Analysis System | **$11,475** |
| **6130S73** Technical Data Analysis and Presentation System | **$13,720** |

Complete system descriptions, option listing and pricing are available through your local Tektronix Sales Office.



**Flexible leasing programs available in the continental U.S.**



*4100A Series Family Terminals*

## 4100A Series

Continuing Tek's commitment to increased value at lower cost, the Terminals Division introduces the complete "A" Series: a range of color graphics terminals, from the inexpensive 4104A to the cost effective 4109A, designed to meet today's market demands.

New A Series features are:

**More and Improved Segments.** The greatest improvements are in the area of segment support. With the new Segment Editing capability, users can modify existing segments without having to re-transmit the entire segment, thus saving CPU and transmission time and costs. Another new feature, Segment Subroutining, is similar to a software subroutine call. By defining an often-used graphic primitive in a segment, it can then be called as often as needed, saving a significant amount of memory. This along with improved memory algorithims, allows a user to define more than three times as many segments as before, without adding any more memory.

**One Megabyte of Memory.** This new option gives the A Series a strong competitive advantage since no other graphics terminals in this price range offers 1 megabyte of memory.

**Expanded Tablet Support.** To meet customer demand, the larger Tek 4958 tablet has been added to the current Tek 4957 tablet support.

**Circular Arcs.** Now, arcs and circles can be drawn with one command and a few points, again saving valuable CPU and communication time.

**Complete 2-Way PPI Support.** Users needing to copy from RS-232 devices can now do so.

**Expanded Copier Support.** The new terminals not only support the full range of Tektronix color copiers, they also support the Tek 4644 Dot Matrix Printer, as well as popular low cost printers such as the HP Thinkjet, Epson FX80, and others, in both graphics and dialog copies.

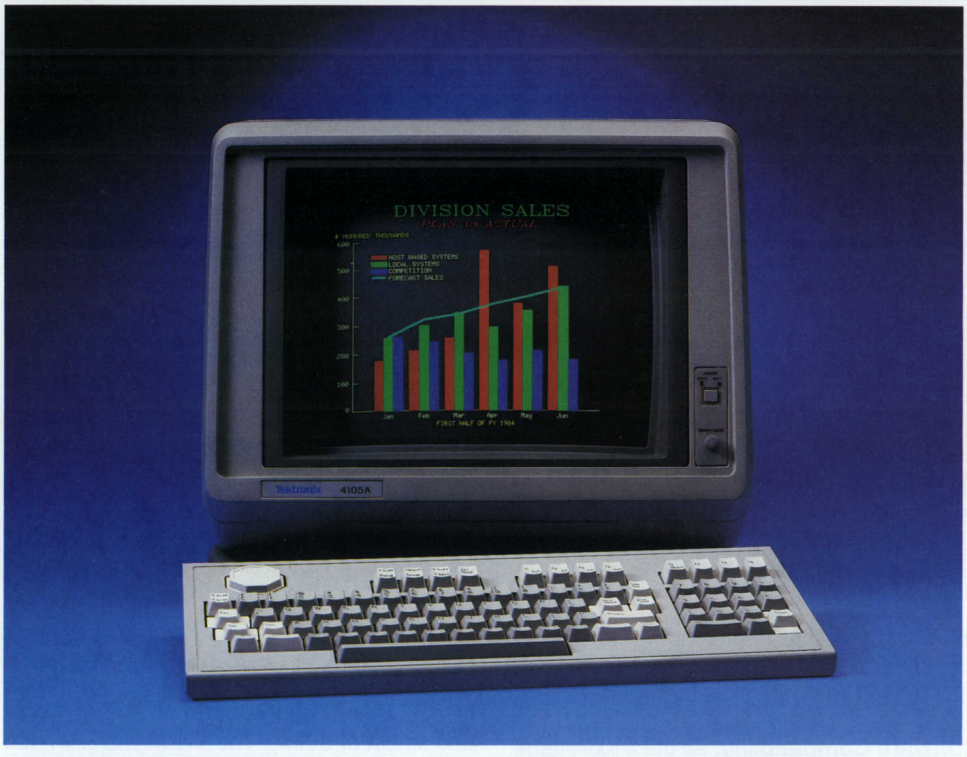
**Software Compatibility.** All the 4100A terminals accept programs written for Tek 4010 terminals and are upward compatible with applications used on the Tek 4110 and 4120 terminals. Some of the software supporting the 4100A line include Tektronix PLOT 10 Interactive Graphics Library, PLOT 10 Graphic Kernel System, PLOT 10 Terminal Control System, PLOT 10 TekniCAD and TekniCAP, DISSPLA and TELL-A-GRAPH, SAS/GRAPH, and a host of others. The 4100A line is VT-100 compatible with powerful editing and word processing abilitites designed to ANSI 3.64 standards. Each 4100A is designed to facilitate easy transition to higher performance terminals as needs change.

### 4100 SERIES TERMINALS SELECTION GUIDE

| | 4104A | 4105A | 4106A/ CX4106A | 4107A/ CX4107A | 4109A/ CX4109A |
|---|---|---|---|---|---|
| **Display Size** | 13-inch | 13-inch | 13-inch | 13-inch | 19-inch |
| **Color Palette** | 64 | 64 | 64 | 64 | 4096 |
| **Displayable Colors: Graphics Alphanumeric** | 4 4 | 8 8 | 16 8 | 16 8 | 16 8 |
| **Pixel Resolution** | 480 x 360 | 480 x 360 | 640 x 480 | 640 x 480 | 640 x 480 |
| **VT-100 compatible commands** | yes | yes | yes | yes | yes |
| **Expanded segment support** | no | no | yes | yes | yes |
| **Arc curve commands** | no | no | yes | yes | yes |
| **Pixel operations** | yes | yes | yes | yes | yes |
| **Two-way peripheral port communications** | no | no | yes | yes | yes |
| **Enhanced color copier support** | yes | yes | yes | yes | yes |
| **Fast monochrome copier support** | yes | yes | yes | yes | yes |
| **4957/4958 Tablet support** | no | no | yes | yes | yes |
| **Megabyte of memory** | no | no | no | yes | yes |
| **4510 Support** | no | no | yes | yes | yes |
| **Page** | 58 | 58 | 58 | 59 | 60 |
| **Prices Begin At** | $2,995 | $3,495 | $5,995/6,995 | $6,995/7,995 | $8,995/9,995 |

*Note: Each terminal supports the 4644, 4691, 4692 & 4695*

# TEK COMPUTER DISPLAY TERMINALS




## *NEW* 4104A
### Computer Display Terminal

**Lowest Cost Tektronix Color Graphics Terminal**

**Fully Compatible with 4010 Graphic Applications**

**Includes VT-100 (ANSI 3.64) Alphanumeric Features**

*A low cost tilt/swivel stand which adjusts the display to the user's need is now available.*

The 4104A brings color graphics within reach of every computer user. The 4104A shares the excellent display characteristics and versatility of the industry standard 4105A, and is fully upward compatible with the 4100 terminal line. The 4104A also shares the 4105A's unprecedented MTBF of 13,000 hours, making it the most reliable graphics terminal in its price range in the world today.

The 4104A has a flicker-free, 60 Hz non-interlaced refresh rate, precision in-line gun with fixed convergence, and anti-glare etched 13-inch (330 mm) display screen. This combination optimizes the 480 x 360 pixel resolution, rivaling more expensive, unbalanced 800 x 240 or 512 x 512 resolution terminals.

The four graphic and four dialog colors, from the palette of 64, can be displayed individually or simultaneously, making up to eight colors available to a user.

### ORDERING INFORMATION

**4104A** Computer Display Terminal **$2,995**
**Includes:** power cord (161-0066-00); RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator manual (070-5789-00); reference guide (070-4528-02).

**OPTIONS**

| | |
|---|---|
| **Option 4A** — United Kingdom Keyboard. | **NC** |
| **Option 4B** — French Keyboard. | **NC** |
| **Option 4C** — Swedish Keyboard. | **NC** |
| **Option 4F** — Danish/Norwegian Keyboard. | **NC** |
| **Option 4G** — German Keyboard. | **NC** |

**INTERNATIONAL POWER PLUG OPTIONS**

| | |
|---|---|
| **Option A1** — Universal Euro 220 V/16 A, 50 Hz. | |
| **Option A2** — UK 240 V/13 A, 50 Hz. | |
| **Option A3** — Australian 240 V/10 A, 50 Hz. | |
| **Option A4** — North American 240 V/15 A, 60 Hz. | |
| **Option A5** — Switzerland 220 V/10 A, 50 Hz. | |

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

| | |
|---|---|
| **N0** — Installation and Set-up | **+$150** |
| **N2** — Service Plan + 2 Years Service | **+$195** |
| **N3** — OEM Service Plan + 12 Months Service | **+$120** |
| **N4** — OEM On-Site Installation & Set-up | **+$150** |

## 4105A Computer Display Terminal

**Low Cost Color Graphics**

**VT-100 (ANSI 3.64) Compatible Alphanumerics**

**Compatible with 4010, 4100, 4110, and 4120 Graphic Terminals**

*A low cost tilt/swivel stand which adjusts the display to the user's need is now available.*

For users with greater graphics demands, the 4105A supplies all the same features as the 4104A, and then some. The 4105A has eight graphic and eight dialog colors, all of which may be easily changed with the local Interactive Color Interface. Also added in the 4105A are an additional 133 predefined fill patterns for polygon fill and pixel operations. Coupled with communication speeds up to 38.4 kbaud, these features ensure easy creation and editing of color graphics and text.

The 4105A has the flicker-free, 60 Hz non-interlaced refresh rate precision in-line gun with fixed convergence, and anti-glare etched 13-inch (330 mm) display screen. This combination optimizes the 480 x 360 pixel resolution, rivaling more expensive, unbalanced 800 x 240 or 512 x 512 resolution terminals.

In graphics mode, the 4105A has eight graphics colors from a palette of 64, eight predefined line types, 11 marker types, and rapid polygon fill with one of the 149 predefined solid or dithered patterns. Graphic windowing enhances effective 4105A resolution to an addressable 4096 x 4096 points.

### ORDERING INFORMATION

**4105A** Computer Display Terminal **$3,495**
**Includes:** Same as 4104A except operator manual (070-4527-02); programmer reference manual (070-4526-03); reference guide (070-4528-03).

**OPTIONS**

Same as 4104A.

**INTERNATIONAL POWER PLUG OPTIONS**

Same as 4104A.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

Same as 4104A.

## 4106A Computer Display Terminal

**Low Cost, Higher Resolution Color Graphics**

**VT-100 (ANSI 3.64) Compatible Alphanumerics**

**Compatible with 4010, 4100, 4110, and 4120 Graphic Terminals**

*A low cost tilt/swivel stand which adjusts the display to the user's need is now available.*

The 4106A rivals costlier graphics displays in resolution, reliability, and alphanumeric capability. Excellent display quality with a 640 x 480 pixel resolution make creation and editing of graphics and text incredibly easy.

The 4106A includes the advanced 4107A graphics features. These include multiple views, segment editing, true local zoom and pan, multiple surfaces, tablet support, peripheral port operations, and more. As users' needs grow, an easily installed upgrade expands the terminal memory from 32 kbytes to 288 kbytes.

A companion product for the IBM environment, the CX4106A is also available. See the CX terminals section for more details.

### ORDERING INFORMATION

**4106A** Computer Display Terminal **$5,995**

**Includes:** Same as 4104A except operator manual (070-4981-02); reference guide (070-4528-02).

**OPTIONS**

Same as 4104A.

**INTERNATIONAL POWER PLUG OPTIONS**

Same as 4104A.

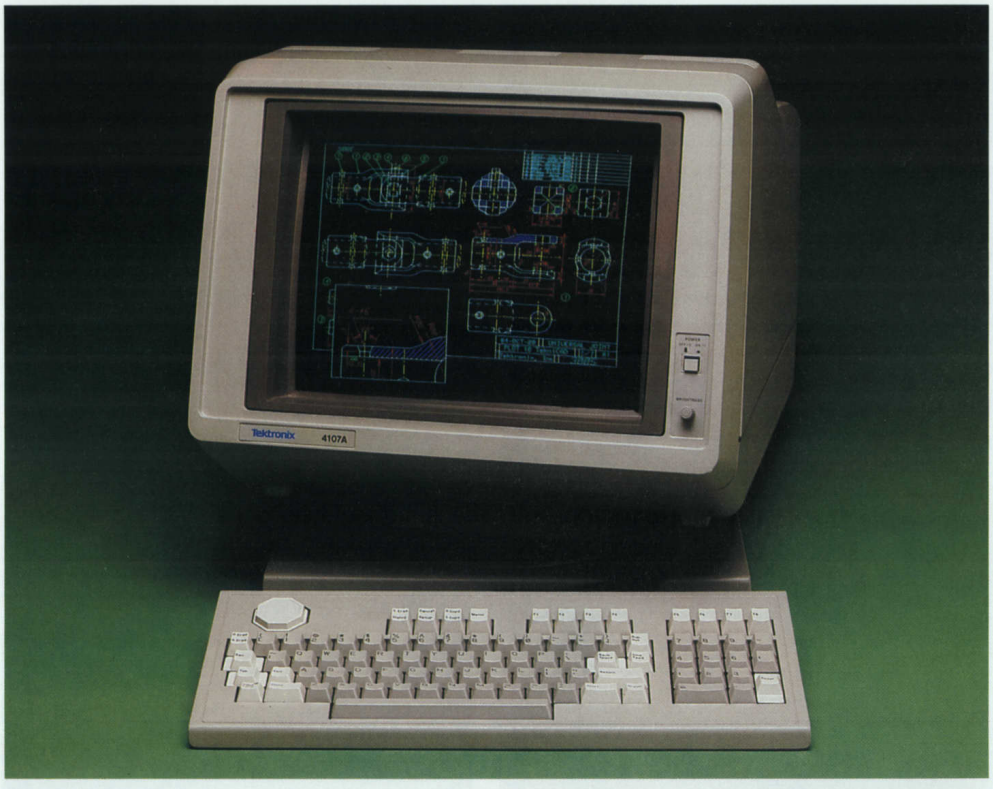
***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

Same as 4104A.

**Workstation Furniture for these products are shown on pages 83 and 84.**

**For direct order of 4104A or 4105A, call 1-800-426-2200, Ext. 431.**
**In Oregon, call collect: (503) 627-9000, Ext. 431.**

**Flexible leasing programs available in the continental U.S.**




## 4107A Computer Display Terminal

**Low Cost, High Performance Color Graphics**

**VT-100 (ANSI 3.64) Compatible Alphanumerics**

**Compatible with 4010, 4100, 4110, and 4120 Graphic Terminals**

*A low cost tilt/swivel stand which adjusts the display to the user's need is now available.*

For advanced graphic applications, the sophisticated 4107A is the price/performance leader. With its advanced graphic abilities, such as segment editing and segment subroutining, advanced pick operations and 2-way peripheral port operations, the 4107A rivals more costly graphic terminals. The 640 x 480 pixel resolution is enhanced by the flicker-free, 60 Hz noninterlaced refresh rate precision in-line gun with fixed convergence, and anti-glare etched 13-inch (330 mm) display screen. Effective screen resolution is 4096 x 4096 points, with true local zoom and pan making effective use of this resolution.

The graphics area supports 16 colors from a palette of 64. Other graphic features include multiple views, multiple surfaces, circular arcs, user definable cursors, tablet support, and up to 1 megabyte of RAM for segments. Also included are eight predefined line styles, 11 marker types, and 149 predefined solid or dithered patterns for polygon fill. Two styles of graphics text may be scaled, rotated, and adjusted in size.

The 4107A supports a wide variety of copiers and printers for both Graphic and Dialog copies. These include the popular Tektronix 4691, 4692 and 4695 Color Graphics Copiers, the Tektronix 4644 monochrome printer, the Hewlett-Packard Thinkjet®, the Epson FX-80™, and many other Epson compatible printers.

A companion product for the IBM environment, the CX4107A is also available. See the CX terminals section for more details.

### ORDERING INFORMATION

**4107A** Computer Display Terminal **$6,995**

**Includes:** 8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator manual (070-4981-02); supplement (to be ordered with A version) (070-5723-00); reference guide (070-4892-02).

**OPTIONS**

| | |
|---|---|
| **Option 21** — 1MB of RAM memory. | **+$2,000** |
| **Option 4A** — United Kingdom Keyboard. | **NC** |
| **Option 4B** — French Keyboard. | **NC** |
| **Option 4C** — Swedish Keyboard. | **NC** |
| **Option 4F** — Danish/Norwegian Keyboard. | **NC** |
| **Option 4G** — German Keyboard. | **NC** |

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

| | |
|---|---|
| **N0** — Installation and Set-up. | **+$150** |
| **N2** — Service Plan + 2 Years Service. | **+$375** |
| **N3** — OEM Service Plan + 12 Months Service. | **+$250** |
| **N4** — OEM On-Site Installation & Set-up. | **+$150** |

**Flexible leasing programs available in the continental U.S.**

## 4109A Computer Display Terminal

**Low Cost, High Performance 19 inch Color Graphics**

**VT-100 (ANSI 3.64) Compatible Alphanumerics**

**Compatible with 4010, 4100, 4110, and 4120 Graphic Terminals**

**RGB Output for External Video Applications**

For advanced graphic applications requiring a large screen and full 4107A compatibility, the cost effective 4109A is the solution. With its advanced graphic abilities, such as segment editing and segment subroutining, advanced pick operations and 2-way peripheral port operations, the 4109A rivals more costly graphic terminals. The 640 x 480 pixel resolution is enhanced by the flicker-free, 60 Hz noninterlaced refresh rate precision in-line gun with fixed convergence, and 19 inch (483 mm) shadow mask display screen. Effective screen resolution is 4096 x 4096 points, with true local zoom and pan making effective use of this resolution.

The graphics area supports 16 colors from a palette of 4096. Other graphic features include multiple views, multiple surfaces, circular arcs, user definable cursors, tablet support, and up to 1 megabyte of RAM for segments. Also included are eight predefined line styles, 11 marker types, and 149 predefined solid or dithered patterns for polygon fill. Two styles of Graphics text may be scaled, rotated, and adjusted in size.

The 4109A supports a wide variety of copiers and printers for both Graphic and Dialog copies. These include the popular Tektronix 4691, 4692 and 4695 Color Graphics Copiers, the Tektronix 4644 monochrome printer, the Hewlett-Packard Thinkjet, the Epson FX-80, and many other Epson compatible printers.

A companion product for the IBM environment, the CX4109A is also available. See the CX terminals section for more details.

### ORDERING INFORMATION

**4109A** Computer Display Terminal **$8,995**

**Includes:** 8 ft power cord (161-0066-00); 12 ft host port RS-232 cable (012-0911-00); pkg of six keyboard overlays (334-5164-00); standard keyboard (119-1592-00); operator manual (070-4981-02); reference guide (070-4892-02).

**OPTIONS**

| | |
|---|---|
| **Option 21** — 1MB of RAM memory. | **+$2,000** |
| **Option 4A** — United Kingdom Keyboard. | **NC** |
| **Option 4B** — French Keyboard. | **NC** |
| **Option 4C** — Swedish Keyboard. | **NC** |
| **Option 4F** — Danish/Norwegian Keyboard. | **NC** |
| **Option 4G** — German Keyboard. | **NC** |

**INTERNATIONAL POWER PLUG OPTIONS**

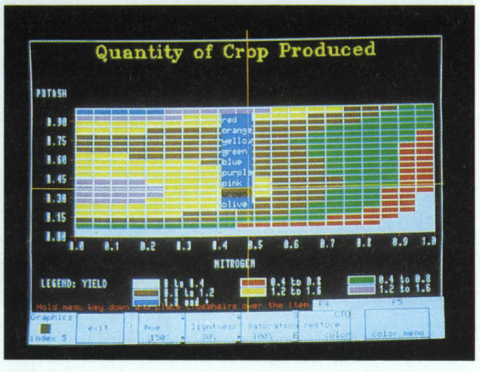
**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

| | |
|---|---|
| **N0** — Installation and Set-up. | **+$150** |
| **N2** — Service Plan + 2 Years Service. | **+$445** |
| **N3** — OEM Service Plan + 12 Months Service. | **+$325** |
| **N4** — OEM On-Site Installation & Set-up. | **+$150** |

# TEK COMPUTER DISPLAY TERMINALS

*CX4100A Series fully supports IBM 3270 color alphanumerics.*




*CX4100A Series menu enables easy user color section.*

## CX4106A/CX4107A/ CX4109A

**A Direct Coaxial Interface to a 3274 Cluster Controller**

**32-Line 3278/3279 Alphanumeric Emulation**

**An IBM-Style Keyboard**

**Expandability Up to 1 MB Local Memory**

**Segment Subroutine and Editing Features**

**Drivers for a Full Range of Tektronix Color Graphics Copiers, the 4510 Color Graphics Rasterizer and Tek 4957 and 4958 Graphics Tablets**

**Drivers for Selected Monochrome Graphics Printers**

The CX4100 Series has all the features of Tektronix's family of low-cost, high-performance 4100 Series terminals, making the benefits of Tektronix's PLOT 10 graphics command set available in IBM 3270 environments. All three terminals feature full plug-compatible IBM 3270 alphanumerics and a familiar IBM-style keyboard.

The CX4100 Series terminals are identical to the 4100 Series terminals in their sophisticated graphics capabilities. They have a 60 Hz noninterlaced display with 4096 x 4096 addressability displayed in a 640 x 480 matrix. This series has the ability to draw solid or dashed lines in up to 16 colors using eight line styles or 11 marker types. Also featured is a rapid area fill, with solid colors or patterns, scalable and rotatable text, true zoom and pan, and local picture segments for storing picture elements in RAM. These segments can be rotated, scaled, and transformed in two dimensions, and used to define the graphics cursor. The CX4100 Series terminals feature up to 64 definable views of the graphics information, multiple bit-planes for layering complex images, and extensive graphic input features such as user-defined cursor, inking, and rubberbanding.

The CX4100 IBM-style keyboard matches those on the 3278 and 3279 IBM terminals: the same arrangement of keys, and identical alphanumeric capability, plus added easy-to-use enhancements, such as individual key programmability, a user-selectable ten-key pad, and a joydisk for quick cursor movement and graphics input.

### ORDERING INFORMATION

| | |
|---|---|
| **CX4106A** Computer Display Terminal | **$6,995** |
| **CX4107A** Computer Display Terminal | **$7,995** |
| **CX4109A** Computer Display Terminal | **$9,995** |

**Flexible leasing programs available in the continental U.S.**

### 4170 S Systems—Drafting and Presentation Graphics Applications

The 4170S3, 4170S4, and 4170S5 bundled systems provide the end-user a range of low-cost, powerful drafting and presentation systems. These systems feature significant cost savings over the price of components purchased separately and fast performance in a single-user, standalone application environment. Installation by Tektronix field personnel is available *at no charge* by ordering the N0 installation option.

The display files developed on the 4170S3/4/5 systems can be translated into formats compatible with other Tektronix implementations of the software. And the 4170 configurations included in the S systems can be upgraded to a full set of programming tools for users who desire local, standalone programmability.

### 4170S3/4170S4 Drafting Systems

The 4170S3 and 4170S4 Drafting Systems feature 4100P30 TekniCAD Computer-Aided Drafting, a high-performance 2D drafting software package. The system includes:

- 4170 Local Graphics Processing Unit, with additional 256 K RAM (total of 512 K RAM) and 10 MB hard disk and hard disk controller.
- The 4100P30 TekniCAD drafting software package.
- A color graphics terminal. The 4170S3 system includes a 4107A terminal; the 4170S4 system includes a 4109A terminal.
- A 4957 Graphics Tablet for graphics input and function selection.

### 4170S5 TekniCAP Presentation System

The 4170S5 TekniCAP Presentation System features the 4100P60 TekniCAP Computer-Aided Presentation software package. This system offers a turnkey solution for persons who want to make transparencies for overhead presentations. The system includes:

- 4170 Local Graphics Processing Unit with 10 MB hard disk and hard disk controller.
- 4100P60 TekniCAP software package.
- Additional system software needed to run TekniCAP.
- A 4107A color graphics terminal.
- A 4695 color graphics copier, with a box of transparency sheets.

## ORDERING INFORMATION

| | |
|---|---|
| **4170S3** Drafting System | **$10,675** |
| **4170S4** Drafting System | **$12,675** |
| **4170S5** TekniCAP Presentation System | **$10,995** |

**OPTIONS**

| | |
|---|---|
| **Option A1** — 220 V Euro Plug. | **NC** |
| **Option A2** — 240 V UK Plug. | **NC** |
| **N0** — Installation (No Charge). | **NC** |
| **N1** — *Warranty-Plus* (One Year). | |
| (for 4170S3) | **+$385** |
| (for 4170S4) | **+$385** |
| (for 4170S5) | **+$770** |

### 4170 Local Graphics Processing Unit

The 4170 provides the 4104A, 4105A, 4106A, 4107A, and 4109A Computer Display Terminals with standalone power specialized for graphics tasks. The 4170 offers all the elements necessary to locally write, edit, compile, link, debug and run programs.

## CHARACTERISTICS

### PROCESSORS

Intel 8086 MPU.

Intel 8087 Numeric Co-Processor.

### MEMORY

Port A 375 ns ≤ memory cycle of Port B <1.2 μs.

**Standard** — 256 K Error Checking and Correcting.

**Option 30** — 512 K Error Checking and Correcting.

### DISK STORAGE

**Standard** — Two each 5¼ in Floppy Disk Drives, 327 K formatted capacity per diskette, IBM PC compatible, 125 Kbits/s transfer rate.

**Option 03** — 5¼ in Winchester Disk Drive, 8 Mbytes formatted capacity, 5 Mbits/s transfer rate.

### COMMUNICATIONS INTERFACE

**Standard** — Host Port RS-232C DTE, Terminal Port RS-232C DCE, two Peripheral Ports RS-232C DCE.

### PARALLEL INTERFACE

**Option 09** — Centronix-Style Parallel Interface.

## ORDERING INFORMATION

**4170** Local Graphics Processing Unit **$5,500**

**Includes:** Cue card (334-0083-00); pkg of 10 blank diskettes (119-1583-01); one set system software diskettes (016-0764-00); 12 ft host port RS-232 cable (012-0911-00); self-test adaptor (067-1043-00); instruction manual.

| | |
|---|---|
| **Option 03*1** — Hard Disk. | **+$3,000** |
| **Option F44** — Disk Interface Flexible Disk. | **NC** |
| **Option 45*1** — Disk Interface Hard and/or Flexible Disk. | **+$1,100** |

*1 *Also available as a Field Upgrade.*

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.

***WARRANTY PLUS* SERVICE PLANS**
**SEE PAGE 457**

| | |
|---|---|
| **N1** — Service Plan +9 Months Service. | **+$340** |

## OPTIONAL ACCESSORIES

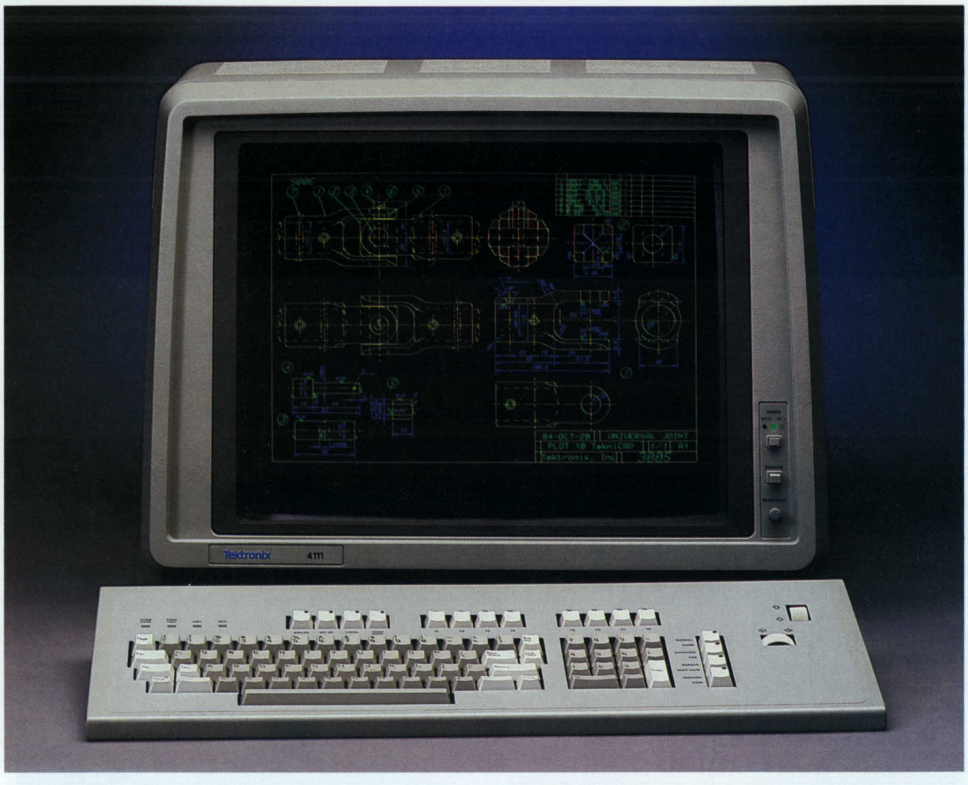
| | |
|---|---|
| **Alignment Diskette** Order 119-1692-00. | **$65** |
| **Extender Board** Order 067-1005-00. | **$350** |

**OEM terms available on this product.**

**Flexible leasing programs available in the continental U.S.**

NEW

COMPUTER DISPLAY TERMINALS




## 4111 Computer Display Terminal

### Advanced Firmware Routines

### Four Bit Planes for Multi-layer Graphics

The 4111 is a personalized, high-resolution computer display terminal that offers superior price/performance characteristics for 2D ME-CAD and drafting applications, EE-CAD (schematic capture, IC design), cartography, and Technical Data Analysis (TDA). The terminal operates in a 60 Hz, noninterlaced mode that minimizes both flicker and eye strain. An anti-reflection enhancement panel further minimizes user fatigue.

Four-bit planes are standard, allowing the simultaneous display of 16 colors for graphics, eight of which can be used in the dailog area. Each bit plane can be treated as a separate display surface permitting the manipulation of layers of data—a feature that is particularly useful with multi-layer drawings such as IC design and printed circuit board design. The 4111's 4096-color palette provides a broad range of shades from which to choose.

4100 Series compatibility is designed in. An extensive set of graphics functions is available, including windowing, multiple views, segments, surface support, and local zoom and pan. Also supported are such graphics input features as rubber-banding, gridding, inking, a user-definable cursor, and easy polygon-fill with any of 16 predefined patterns or a user defined pattern. The 256 kB local RAM is available to store picture elements for later use; 1 MB can be added optionally to bring the total RAM memory up to 1.2 MB.

Advanced firmware routines aid the applications programmer in developing graphics software with a very interactive operator interface and excellent performance. Included in the 4111's firmware are routines that handle segment editing, segment subroutines, pick operations, host window management, multiple scrolling dialog areas, and pop-up menus.

## CHARACTERISTICS

### DISPLAY

**Size** — 483 mm (19 in) diagonal.

**Viewing Area** — 356 mm x 267 mm (14 in x 10.5 in).

**Color Palette**— 4096.

### DISPLAYABLE COLORS

**Graphics** — 16.

**Alphanumerics** — Eight (chosen from a total of 16).

### DIALOG AREA

132 characters x 48 lines.

### ADDRESSABILITY

1024 x 768 pixels (4 billion x 4 billion addressable points).

**GIN Devices** — Thumbwheels standard; mouse, joystick, tablet optional.

**Local Memory** — 256 kbytes expandable to 1.2 MB.

### COMMUNICATIONS

RS-232-C, RS-422 high-speed serial interface.

**6130** — 230 kbaud.

**RGB Video Out** — 60 Hz noninterlaced RS-343 levels.

**Maximum Baud Rate with Flagging** — 38.4 k.

**Copier Support** — 4691, 4692, 4695.

## ORDERING INFORMATION

**4111** Computer Display Terminal **$12,950**

**Includes:** Power cord (161-0066-00); RS-232-C cable (012-0911-00); 4111 operator's manual (070-5683-00); 4110/4120 Series reference guide (070-5142-01); An Introduction to Computer Color Graphics (070-5239-00); function key overlays (package of six) (334-3290-02); standard keyboard (119-2208-00); IDD user's survey card (062-7235-01).

### OPTIONS

**Option 2C** — Additional 1 Mbyte of RAM Memory. **+$2,500**

**Option 4K** — Katakana Keyboard. **+$120**

**Option 4M** — Mouse. **+$100**

**Option 49** — Rental Identification Tag. **NC**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

**Option A2** — UK 240 V/13 A, 50 Hz.

**Option A3** — Australian 240 V/10 A, 50 Hz.

**Option A4** — North American 240 V/15 A, 60 Hz.

**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### *WARRANTY-PLUS* SERVICE PLANS

SEE PAGE 457

**NØ** — On-site installation and set-up. **+$150**

**N1** — On-site service plan, +9 Months upon warranty expiration. **+$600**

**N3** — OEM On-site service plan, +12 Months (transferable). **+$800**

**N4** — OEM On-site installation and set-up (transferable). **+$150**

## OPTIONAL ACCESSORIES

**RS-232-C Loopback Connector** — Order 067-1043-00 **$30**

**RS-422 Loopback Connector** — Order 013-0218-00 **$70**

**Centronics Loopback Connector** — Order 067-1138-00 **$50**

**RS-422 Communication Cable** — Order 012-1136-00 **$50**

**Function Key Overlays** — Package of six. Order 334-3290-02 **$2.25**

**4110/4120 Series Command Reference Manual** — Order 070-5141-01 **$200**

**4110/4120 Series Host Programmers Manual** — Order 070-4664-03 **$75**

**4111 Service Manual** — Order 070-5644-00 **$150**

**GMA 302 19-in Color Raster Monitor Service Manual** — Order 070-5215-00 **$125**

**4120 Series Serial Keyboard Service Manual** — Order 070-5276-00 **$50**

**Joystick Connector EMI Filter** — Order 131-3371-00 **$26**

**Test Graticule** — Order 067-1244-00 **$235**

**Extender Card** — Order 067-1252-00 **$345**

**4111 Field Kits (F-Kits)**

All F-kits come with appropriate documentation.

4111F2C 1 MB of RAM—Field Upgrade. Brings 4111 terminal RAM memory up to 1.2 MB by adding 1 MB of RAM to the standard 256 kB of RAM.

**NØ** — Please see *WARRANTY-PLUS* service option description.

**N4** — Please see *WARRANTY-PLUS* service option description.

**4100 F4M Mouse, Field Upgrade** — allows the customer to plug the mouse into his keyboard.



**Flexible leasing programs available in the continental U.S.**

# 4114B Computer Display Terminal

**The Best Fit for Very Dense Graphics and Fine Line Quality Graphics**

**Direct View Storage Tube with Local Picture Segments**

**2D Transforms, Fast Redraw, Enhanced Refresh**

The 4114B sets new standards of fast graphics throughput and enhanced user interactivity. This terminal is designed to satisfy the evolving needs of graphics users for faster, more versatile throughput in high density graphics applications. Its local intelligence and expandable memory can significantly reduce the delays and costs associated with overdependence on a host computer.

Features include a direct view storage tube with local picture segments, 2D transforms, refresh support, fast redraw and compatibility with the Tektronix 4010 Series and 4110B Series. The 4114B is available in pedestal or desk (4114B30) configurations.

## CHARACTERISTICS

### DISPLAY

**Medium** — Direct view storage tube with Directed Beam Refresh

**Size** — 368.3 mm x 276.9 mm (14.5 in x 10.9 in)

**Addressable Points** — 4096 x 4096

**Displayable Points** — 4096 x 3072

### KEYBOARD

**Normal Keyboard** — 72 typewriter-paired uppercase and lowercase, programmable and auto repeating (five lighted)

**Function Keys** — Eight (16 user-definable and programmable functions)

### OTHER CONTROLS

**Graphic cursor thumbwheel**

**Audible bell alarm**

### ALPHANUMERIC MODE

**Standard Character Set** — 94 ASCII displayable or 128 displayable *snoopy mode*.

### GRAPHICS MODE

**Addressability** — 4096 x 4096.

**Graphic Command Syntax** — PLOT 10 compatible.

**Line Types** — Solid, dashed, defocused.

**Drawing Speed (Storage)** — 134 meters/sec.

**Drawing Speed (Refresh)** — 537 meters/sec.

**Graphic Primitives** — Vectors, user-defined text, etc.

**Interactive Graphics** — Thumbwheels control graphic cursor; keys control scrolling and alpha cursor position

**Computer Interfaces** — Basic data communications interface: EIA RS-232C compatible (full-duplex or half-duplex)

### AC POWER

**Line Voltage Ranges** — 90 V ac to 132 V ac at 11 A maximum or 180 V ac to 250 V ac at 5.5 A max.

**Line Frequency** — 48 Hz to 62 Hz.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 597 | 23.5 |
| Height | 1290 | 51.0 |
| Depth | 813 | 32.0 |
| **Weight** | **kg** | **lb** |
| Net | 107.5 | 237.0 |

## ORDERING INFORMATION

**4114B** Computer Display Terminal **$17,900**

**4114B30** Computer Display Terminal **$19,400**

**Includes:** Power cord (161-0123-00); pedestal to display power cable (161-0145-00); RS-232 cable (012-0911-00); relegendable key caps (366-1882-00); function key overlays (334-3290-01); 4114B operator's manual (070-4707-00).

### OPTIONS

**Option 01** — Extended Communications. **+$1000**

**Option 2A** — Additional 256 kbytes of RAM with ECC. **+$2,500**

**Option 2B** — Additional 512 kbytes of RAM with ECC. **+$5,000**

**Option 10** — Three-Port Peripheral Interface. **+$1,600**

**Option 13** — 11 in x 11 in Graphic Tablet with pen. **NC**

**Option 14** — 30 in x 40 in Graphic Tablet with pen. **+$4,950**

**Option 31** — Color Enhanced Refresh. **+$1,000**

**Option 32** — Table Module (4114B30 only). **+$500**

**Option 41** — Extra Capacity Fan (90-110 V operation only). **NC**

**Option 42** — Single Flexible Disk and Disk Controller. **+$2,000**

**Option 43** — Dual Flexible Disk and Disk Controller. **+$2,800**

**Option 45** — Mass Storage Interface Bus. **+$1,500**

**Option 52** — Specify voltage and Hz. **NC**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A.

**Option A2** — UK 240 V/13 A.

**Option A3** — Australian 240 V/10 A.

**Option A4** — North American 240 V/15 A.

**Option A5** — Switzerland 230 V/16 A.

All options and displays will be set for 50 Hz operation when these options specify 50 Hz.

### *WARRANTY-PLUS* SERVICE PLANS

**SEE PAGE 457**

**N1** — *Warranty-Plus* Service Plan +9 Months Service. **+$810**

**N3** — *Warranty-Plus* Service Plan +12 Months Service. **+$1,080**

**Flexible leasing programs available in the continental U.S.**

# TEK HIGH PERFORMANCE 2D & 3D COLOR GRAPHICS WORKSTATIONS

## 4120 Series

### CAD Graphics Workstations

**A Natural Growth Path from 2D to 3D Wireframe to 3D Shaded Surfaces**

**Easy Integration into a Range of Computational Environments**

**Flicker-Free Display, Choice of Dynamic or Autoconvergence**

The latest graphics products from Tektronix offer you a flexible, cost-effective way to integrate one CAD technology into the next. With their powerful new 80286/80287 processor sets and sharp, dynamically-converged screens, all three graphic systems are engineered to add performance and reduce project design time.

Compatible not only with each other, but with a 4115B and other members of the 4110 Series, the new 4120 graphic systems are a clear demonstration of Tek's commitment to updating, not outdating, your existing investment.

**The 4120 Series adds new potential for return on your graphics investment.** Compatibility with Tek 4110 products means there are no new user interfaces to learn, no data bases to reconstruct. Consequently, training time stays low. Productivity remains high.

Future upgrade paths within the 4120 Series are already defined. For example, Tek's 4125 2D terminal can be upgraded to 3D wireframe performance with the field-installable 4115F58 Option 02, putting the powerful functions of the 4128 at your fingertips. Add the 4100F59 enhancement and take your capabilities all the way to the 4129's shaded surface modeling.

For 4115B systems, users can evolve to 4125 capabilities via the 4115F55 and 4115F56, or upgrade even further to 4128 capabilities with the 4115F58 Option 01.

**User-knowledge and hardware are not obsoleted.** The processors in Tek's new CAD systems and the 4110 Series share the same instruction set, so you continue to add new capabilities by utilizing powerful new commands.

What's more, if you're running 4115B PLOT 10 IGL or GKS applications, you can switch to the 4125 without modifying code. You can also run TekniCAD—Tek's own computer-aided drafting package—as well as the packages of many major CAD software vendors.

*Each member of the 4120 Series is driven by an Intel 8286/80287 processor set and features a display with Dynamic Convergence; firmware with embedded commands for segment editing, segment subroutines and pick operations; a user interactive keyboard; and 4110 Series compatibility.*

### 4120 SELECTION GUIDE

| | 4125 | 4128 | 4129 |
|---|---|---|---|
| **3-D Wireframe** | Optional | yes | yes |
| **3-D Shaded Surface** | Optional | Optional | yes |
| **Display Size** | 19 inch | 19 inch | 19 inch |
| **Viewing Area** | 13.5 inch x 10.8 inch | 13.5 inch x 10.8 inch | 13.5 inch x 10.8 inch |
| **Pixel Resolution** | 1280 x 1024 | 1280 x 1024 | 1280 x 1024 |
| **Convergence** | | | |
| 0.3 mm with Dynamic (Standard) | yes | yes | yes |
| 0.25 mm with Auto (Optional) | yes | yes | yes |
| **Displayable Colors** | | | |
| Standard | 4 | 16 | 256 |
| Optional | 16/64/256 | 256 | 4096 (with dithering) |
| Dialog Areas | 64 | 64 | 64 |
| **Color Palette** | 16 million | 16 million | 16 million |
| **Bit Planes** | | | |
| Standard | 2 | 4 | 8 |
| Optional | 4/6/8 | 8 | 0 |
| **Windowing Pan/Zoom** | yes<br>yes 2-D | yes<br>yes 2-D/3-D | yes<br>yes 2-D/3-D |
| **Segments/Subroutines** | yes | yes | yes |
| **Memory** | | | |
| Standard | 288 K | 288 K | 288 K |
| Optional | 800 K | 800 K | 800 K |
| **Communications** | | | |
| Standard | 1 RS232C I/F | 1 RS232C I/F | 1 RS232C I/F |
| Optional | Parallel & serial I/Fs | Parallel & serial I/Fs | Parallel & serial I/Fs |
| **Coordinate Space** | | | |
| 32 Bit (2-D) | yes | yes | yes |
| 24 Bit (3-D) | | yes | yes |
| **Configuration** | | | |
| Pedestal | yes | | |
| Modular | yes | yes | yes |
| **4120 Peripheral Support** | | | |
| 4695 Copier | yes Opt 19 | yes Opt 19 | yes Opt 19 |
| 4691/4692 Copier | yes | yes | yes |
| 4510 Rasterizer | yes | yes | yes |
| 4958 Graphic Tablet | yes Opt 10 | yes Opt 10 | yes Opt 10 |
| **Prices Begin At** | $19,950 | $25,000 | $35,000 |

**Greater user interactivity results from ergonomically designed hardware.** Users of Tek's new CAD graphics workstations will discover their own performance is greatly enhanced by the ergonomics built into each configuration. Tek's new advanced user-friendly keyboard in the 4120 Series features a numeric keypad, thumbwheels for graphic input, eight dedicated programmable function keys and ports for joystick and mouse and a complete, easy-to-use viewing system implemented from the keyboard.

By coupling this user interactivity with state-of-the-art graphics, you can speed development and execution of design. This results in increased productivity for CAD applications like structural analysis, finite element modeling, thermal and vibrational analysis, schematic capture, integrated circuit design and more.

Up to 64 scrollable dialog areas can be displayed simultaneously, providing valuable new capabilities for host window management. The user can edit one text file while referring to others on the screen at the same time. Since each dialog area has its own text buffer, it may be positioned to overlap others. And even though a dialog area may be partially obscured as a result, it may still be scrolled.

Pop-up menus are also supported. Small areas of screen text and graphics can be stored in local memory and then redisplayed as required. This transient information may be brought on and off the screen at the touch of a key without disturbing the main graphics under development.

### Applications and Compatibility

The 4125 meets 2D design engineering needs in both electrical and mechanical environments. The 3D capabilities of the 4128 and 4129 will find extensive use in the mechanical CAD environment, for such tasks as design, structural analysis, finite element modeling and interference modeling for piping layout. The shading capabilities of the 4129 make it well suited for cartography applications.

All three workstations are compatible with Tektronix' 4100 Series products and the 6130 Intelligent Graphics Workstations. Color hard copy can be obtained with Tektronix 4691, 4692, and 4695 Color Graphics Copiers. The 4120 Series also supports Tektronix Computer-Aided Drafting (TekniCAD) software.

## 4125 High Performance 2D Color Graphics Workstations

**80286/80287 Processor Based**

**Dynamically Converged Display (Optional)**

**Fast Draw and Fill**

The 4125 Color Graphics Workstation incorporates advanced graphics with local processing power and ultra sharp display qualities to provide CAD developers and users with increased utility and performance. The workstation speeds development and execution of the complex, high density graphics associated with mechanical and electrical engineering, cartography, and other graphics-oriented professions.

### Advanced Display

The Tek 4125 employs a 19-inch color raster display operating in a 60 Hz, noninterlaced mode for flicker-free performance. An addressable pixel matrix of 1280 x 1024 ensures crisp, precise resolution of the finest detail in graphics images.

A precision in-line gun CRT is employed for maximum convergence stability. This is supplemented by optional dynamic convergence correction that adjusts as the electron beam scans, providing convergence accuracy of 0.3 mm over the entire display area.

### Segments and Local Picture Storage

Embedded in the firmware and microcode of the 4125 are convenient commands for segment editing, segment subroutines, and pick operations that greatly reduce development time and augment productivity.

## ORDERING INFORMATION

| | |
|---|---|
| **4125** High Performance 2D Color Graphics Workstation (Modular Configuration) | **$19,950** |
| **4125P** High Performance 2D Color Graphics Workstation (Pedestal Configuration) | **$19,950** |

**OPTIONS**

| | |
|---|---|
| **Option 01** — Extended Communications Interface. | **+$1,000** |
| **Option 05** — IBM Coax I/F. | **+$1,995** |
| **Option 06** — Projector I/F. | **+$4,800** |
| **Option 2A** — Additional 256 kbytes RAM with ECC. | **+$2,500** |
| **Option 2B** — Additional 512 kbytes RAM with ECC. | **+$5,000** |
| **Option 3A** — DMA Interface for DEC, PDP-11 VAX Computers. | **+$4,600** |
| **Option 3B** — 30 ft Cable for Option 3A (must be ordered separately). | **+$250** |
| **Option 3C** — RS422 I/F to 6130. | **+$1,500** |
| **Option 4K** — Katakana Keyboard. | **+$175** |
| **Option 4M** — Mouse. | **+$100** |
| **Option 10** — Three-Port Peripheral Interface. | **+$1,600** |
| **Option 19** — 4690 Series Color Copier Interface. | **+$1,100** |
| **Option 22** — Additional 2-Bit Planes Display Memory. | **+$3,000** |
| **Option 23** — Additional 4-Bit Planes Display Memory. | **+$6,000** |
| **Option 31** — Autoconverged Display. | **+$2,000** |
| **Option 42** — Single Flexible Disk and Controller. | **+$2,000** |
| **Option 43** — Dual Flexible Disk and Controller. | **+$2,800** |
| **Option 45** — Mass Storage Interface. | **+$1,500** |
| **Option 46** — 8 MB Winchester Disk (4125 modular configuration only). | **+$2,600** |
| **Option 47** — Dual 8 MB Winchester Disk (4125 modular configuration only). | **+$4,100** |

4125 modular configuration includes display module and keyboard; workstation table, display stand, and ergonomic chair are all optionally available.

**Flexible leasing programs available in the continental U.S.**

# TEK HIGH PERFORMANCE 2D & 3D COLOR GRAPHICS WORKSTATIONS

## 4128/4129

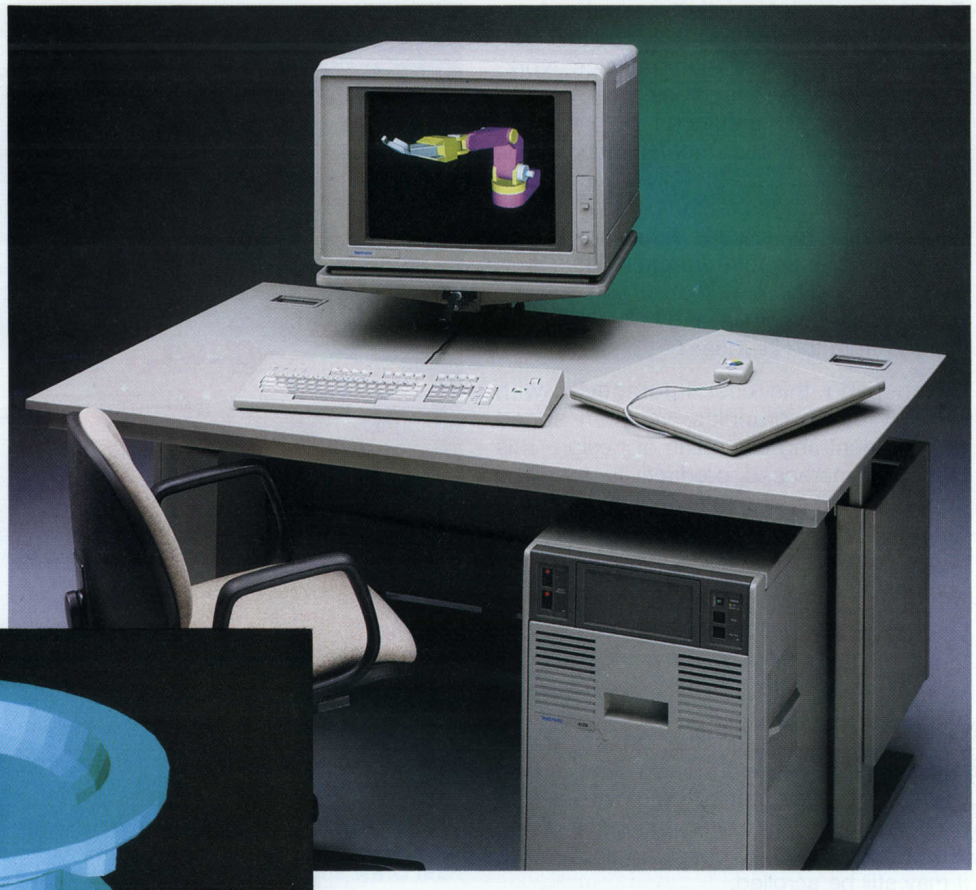
### 3D Color Graphics Workstations

**3D Wireframe/Shaded Surface Color Graphics**

**3D Matrix Transforms**

**Rapid Data Communication—to 38.4 kbaud**

The 4128 and 4129 are members of a new family of compatible, high performance computer graphics systems. Both include the same 2D functionality of a 4125, but offer varying levels of 3D performance. Available in modular configurations only, the 4128 and 4129 feature a new keyboard that includes a numeric keypad and ports for a joystick and mouse. Both the 4128 and 4129 have 3D wireframe capability built into their firmware and microcode in addition to the standard 4125 2D feature set.



An 80286/80287 processor set drives each unit and provides rapid data communications—at rates up to 38.4 kbaud. Both units come with 288 kbytes of RAM, expandable to 800 k. The 4128 offers 4-bit planes and the 4129 is equipped with 8-bit planes as standard. Both share a new, high-resolution 1280 x 1024 in-line display with dynamic convergence.

**4129 Special Features.** The 4129 also includes hardware enhancements for 3D shaded surfaces. Two additional circuit boards and a full 8-bit planes (standard) provide the mechanical engineering designer with all the necessary tools for local shading, hidden line removal and hidden surface removal, and the manipulation of surface-image 3D objects.

**Sectioning.** A useful feature of the 4129 is the ability to section a 3D shaded object. An object may be sliced with two "cuts" or sectioning planes of user defined proportions. These sectioning planes are in addition to the six clipping planes used for viewing operations.

**Shading.** The 4129 offers three different methods of surface shading—constant, cosine, and Gouraud. The colors used to shade a surface are defined in a contiguous set of color map indices that represent a range of intensities.

## ORDERING INFORMATION

| | |
|---|---|
| **4128** 3D Wireframe Color Graphics Workstation | **$25,000** |
| **4129** 3D Shaded Surfaces Color Graphics Workstation | **$35,000** |
| **OPTIONS** | |
| **Option 01** — Extended Communications Interface. | **+$1,000** |
| **Option 2A** — Additional 256 kbytes RAM with ECC. | **+$2,500** |
| **Option 2B** — Additional 512 kbytes RAM with ECC. | **+$5,000** |
| **Option 3A** — DMA Interface for DEC, PDP-11 VAX Computers. | **+$4,600** |
| **Option 3B** — 30 ft Cable for Option 3A (must be ordered separately). | **+$250** |
| **Option 4K** — Katakana Keyboard. | **+$175** |
| **Option 4M** — Mouse. | **+$100** |
| **Option 10** — Three-Port Peripheral Interface. | **+$1,600** |
| **Option 19** — 4690 Series Color Copier Interface. | **+$1,100** |
| **Option 22** — Additional 2-Bit Planes Display Memory. | **+$3,000** |
| **Option 23** — Additional 4-Bit Planes Display Memory. | **+$6,000** |
| **Option 31** — Autoconverged Display. | **+$2,000** |
| **Option 42** — Single Flexible Disk and Controller. | **+$2,000** |
| **Option 43** — Dual Flexible Disk and Controller. | **+$2,800** |
| **Option 45** — Mass Storage Interface. | **+$1,500** |
| **Option 46** — 8 MB Winchester Disk (4125 modular configuration only). | **+$2,600** |

**Flexible leasing programs available in the continental U.S.**

# Local Programmability

## For 4120 Series Terminals

**Powerful State-Of-The-Art Graphics Under User-Written Software Control**

**Local Access to Graphics Manipulation Capabilities**

**CP/M-86**

**ANSI FORTRAN 77**

**Core Graphics Package (PLOT 10 IGL)**

### Local Programmability Puts Graphics Computer Power in the Hands of the User

The 4110B/410X Series Local Programmability gives terminals independence from host computers by equipping them with local intelligence and processing power. Local Programmability supplies the elements needed to locally develop and run programs; to access the graphics and alphanumeric features resident in the 4110B Series and 410X firmware; and to control peripherals connected to the terminal.

The package for 4110B Series terminals consists of a disk-based CP/M-86 operating system, FORTRAN-86 compiler, ASM-86 or ASM86 macro assembler; utility programs; and a library of DTI (Direct Terminal Interface) subroutines that enable the FORTRAN programmer to exercise all 4100 Series terminal features. All package components are also available on the 4170 with 410X terminals. Optionally, a local version of Tektronix' PLOT 10 IGL is available.

### Increased Productivity Through Distributed Processing

Local Programmability gives the user the flexibility to run programs locally or through a host. By promoting more efficient use of the host system, Local Programmability cuts costly CPU time, frees the host to do the kinds of processing it does best, and allows the host to support more terminals. Many CAD/CAM, data analysis and graphing applications can be written and run entirely without host support.

### Software Compatibility Across 4100 Line

User-developed software using the Direct Terminal Interface is upward-compatible from 410X to 4110B terminals if common terminal firmware features are supported. This compatibility allows easy portability of applications from low to high-end terminals without loss of software investment.

With a local version of PLOT 10 IGL, existing IGL-based host programs can be run locally on 410X and 4110B terminals and easily moved to other Tektronix terminals (such as 4010 or 4020 Series). The user can thus choose where an application will run most efficiently—on the host, the terminal or a combination of the two.

### Series-Wide Compatibility

Local Programmability runs on all 4110B Series terminals and on the 4170. The recommended system configuration includes a minimum of 256 kbytes of RAM. For program development the terminal needs two disk drives, although only one drive is needed to run programs locally.

## CHARACTERISTICS
## GENERAL INFORMATION

**Memory Requirements —** 256 kbytes.

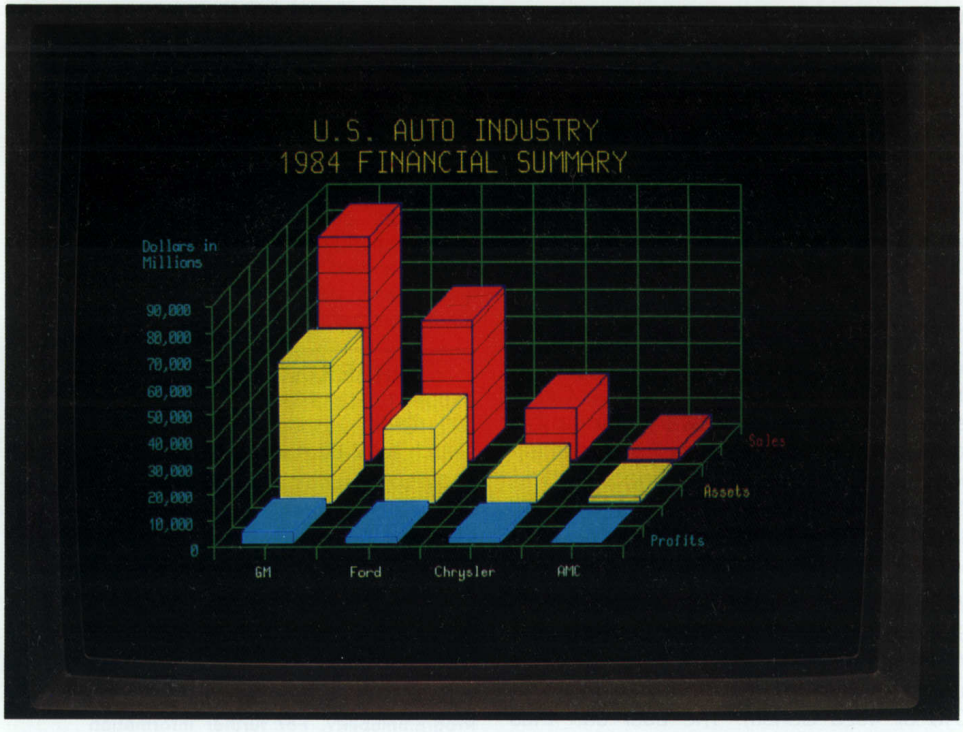
**Equipment Requirements —** 4110B Computer Display Terminal or 4170 Local Graphics Processing Unit supporting 410X Series Computer Display Terminals. Dual disk functionality provided by any of the following: dual floppy disk drives, floppy disk and Winchester drive. Requires at least one floppy for 4110B's. 4170 has two floppy disks standard. Program execution requires at least a single disk drive and sufficient memory to run the program.

## ORDERING INFORMATION

| | |
|---|---|
| **4100P01** FORTRAN, CP/M-86 and DTI (CP/M includes the Digital Research ASM-86 Assembler | **$1,000** |
| **4100P02** Assemblers (Intel ASM86 and Digital Research ASM-86), CP/M-86 and DTI | **$1,000** |
| **4100P11** Intel FORTRAN-86. Requires 4100P01 or 4100P02 | **$500** |
| **4100P12** Intel ASM86. Requires 4100P01 or 4100P02 | **$500** |

**Tektronix offers user training on Local Programmability. For further information contact the Customer Training Registrar at (503) 685-3808 or your nearest Tektronix sales office.**

**OEM terms available on this product.**




*PLOT 10 GKS*

# PLOT 10 Graphics Software

**For 4100 and 4110/4120 Series Terminals**

Tektronix has been setting graphics standards for over a decade. Our new products reflect the implementation of the evolving international standards and the concepts that underlie those standards—software portability and device independence. The goal is to protect your software investment and provide a hardware growth path, and Tek software is designed to meet your changing needs.

Tektronix offers PLOT 10 products to make that goal a reality. PLOT 10 software takes advantage of the graphic capabilities of the 4010, 4100, and 4110/20 Series computer display terminals together with our color copiers.

PLOT 10 includes applications software as well as powerful tools to build applications to suit your specific needs.

### Software Support

When you buy Tektronix software, you are also investing in the people and services behind the product. A Software Update Agreement provides current releases of Tek licensed software products, updates to the documentation, along with additional information on applications and enhancements. The TAS (Technical Assistance Services) are designed to supplement your own resources and to provide training as well as short-term consulting during your software implementation. These combined programs help you get maximum benefit from your Tektronix software products.

### Peripheral Support for Device-Independent Graphics

PLOT 10 products are packaged with device drivers for graphics hardware products. Applications can be written without concern for the physical attributes of a device because the specifics reside in these device-dependent software modules. Many non-Tektronix products are advertising PLOT 10 compatibility; a special driver may not even be needed. PLOT 10 GKS includes drivers for Tektronix terminals, plotters and digitizing tablets as well as selected DEC and IBM graphics terminals. In addition, a device driver model and its documentation are provided offering the professional programmer a tool to develop drivers for non-Tek devices. PLOT 10 IGL also includes a full complement of device drivers to support the entire 4100 and 4110/4120 lines, and selected DEC and IBM graphic terminals.

### Software Portability

Portability has always been the ultimate goal of the graphics standards efforts. Now it is not only possible to transport applications to a variety of host computers, but it is also possible to move applications to workstations using local programmability. Implementations of PLOT 10 TCS (the Terminal Control System that provides the basic graphics building blocks) and PLOT 10 IGL are available locally on 4100 series units. Options add advanced capabilities to the local version of IGL including line smoothing and 3-D graphics routines providing the power of mainframes computer graphics with the benefits of local programmability. An important feature of local programmability means enhanced interactivity at local processor speed rather than data communication line rates.

Existing applications on the host can be downloaded and run locally, thereby increasing interactivity and saving storage costs.

Product overviews and specification data follows. We invite you to ask your local Tektronix Sales Engineer for a demonstration.

## PLOT 10 APPLICATIONS SOFTWARE

PLOT 10 application software has been built to take full advantage of the powerful features included in the 4100 and 4110/20 terminals.

### PLOT 10 TekniCAD (Computer-Aided Drafting)

PLOT 10 TekniCAD is a complete computer-aided drafting system for producing and maintaining design documentation. It is an interactive system that enables you to construct geometry, create and store specialized symbols, and annotate and dimension drawings quickly, simply, and accurately.

TekniCAD performs standard drafting functions through a highly responsive user interface. This allows drafters, engineers, scientists and technical illustrators to create high quality drawings without extensive training or knowledge of complex command languages.

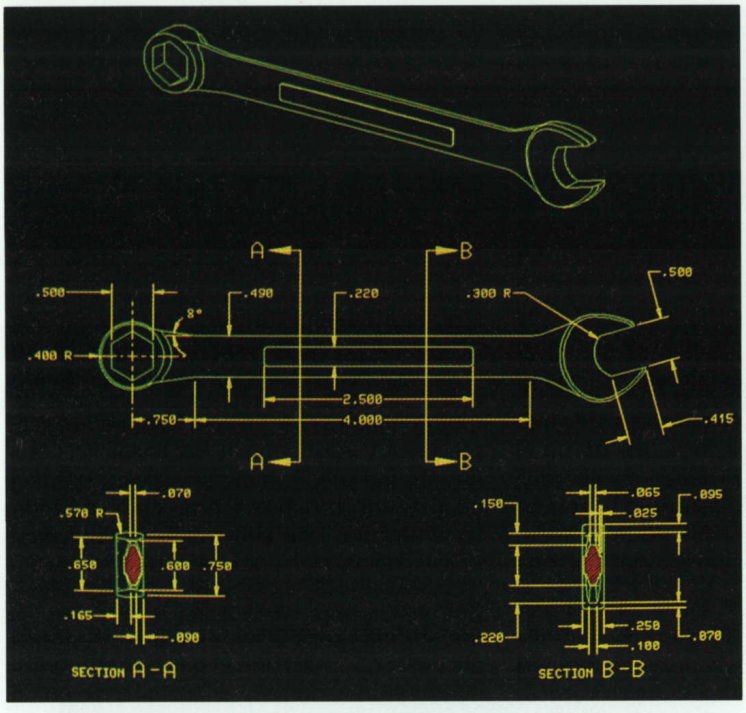
TekniCAD adheres to both ANSI Y14 and ISO drafting standards, and is still flexible enough to be easily adapted to individualized drafting standards.

Tektronix PLOT 10 CADDPORT, a related product, provides a link between TekniCAD and computer-aided design packages of other vendors. This allows TekniCAD to function as the drafting component of a complete CAD/CAM system.

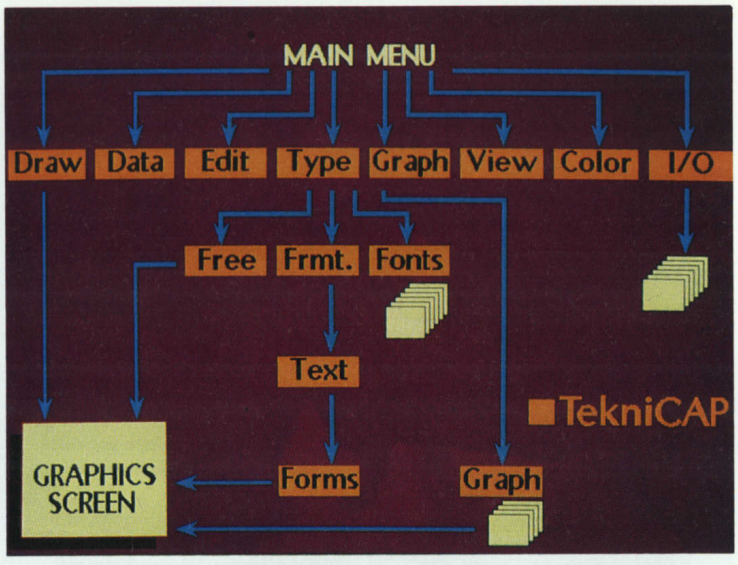
### PLOT 10 TekniCAP (Computer-Aided Presentations)

PLOT 10 TekniCAP is designed especially for the production of high-quality graphics for business and technical presentations. TekniCAP makes it easy to show the results of data analysis programs, to prepare overheads and 35 mm slides, and to create illustrations and designs for color graphics applications.

The TekniCAP package includes a data graphing module that lets you create line graphs, bar graphs, and pie graphs, either from data entered at the keyboard or from an existing data file. But TekniCAP is much more than a graphing package. It includes eight separate *modules*, each designed for




PLOT 10 TekniCAD




PLOT 10 TekniCAP

a specific purpose. These modules help you design formatted lists with bulleted or numbered items, create standard data graphs, place multiple graphs or pictures on a single display, and even schedule a series of displays for automatic output to a color hard copy device. And the menu system and defaults built into all TekniCAP modules make it easy to learn and to use.

Color is a major part of presentation graphics, and TekniCAP makes it easy to select just the colors you want. There are 16 palettes defined and optimized for various hardware configurations and requirements. Or you can define your own colors, using any color from the terminal's color palette.

Since TekniCAP was designed specifically for Tektronix equipment, it takes full advantage of terminal features and hardware compatibility. TekniCAP runs on Tektronix CP/M-86 based products (the 4170 Local Graphics Processing Unit and 4110/4120 Series terminals) as well as the 6130 Workstations. It is also fully supported by the 4690 Series color hard copy units.

## PLOT 10 STANDARD TOOLS

PLOT 10 consists of five software packages, each optimized for different graphics applications: Graphical Kernel System, Interactive Graphics Library, Terminal Control System, Software Terminal Interface, and Graphic Display Interface.

### PLOT 10 Graphical Kernal System (GKS)

PLOT 10 GKS is a FORTRAN '77 subroutine library conforming to the GKS International Standard ISO/IS 7942, Level 2B and ANSI/ANS X3.124 1985. PLOT 10 GKS extensively supports the engineering and scientific workstation environment for a variety of technical data analysis and CAD/CAM applications. Capabilities include 2D graphics, color control, workstation control, text manipulation and fonts, segments, and separate window-viewport control of interconnected devices. Full implementations exist for DEC and IBM environments.

### PLOT 10 Interactive Graphics Library (IGL)

PLOT 10 IGL is a library of FORTRAN '77 subroutines based on the SIGGRAPH Core proposal, designed for use in the development of application programs requiring 2D and 3D graphics output. The approach used is independent of display technology and provides full control of color displays, line smoothing and contouring algorithms, and high-resolution graphics text fonts. Both simple and intelligent terminals are supported, including emulation of many features for device independence as well as model input/output routines.

### PLOT 10 Terminal Control System (TCS)

PLOT 10 TCS is a FORTRAN '66 subroutine library designed to aid the graphics application programmer. The system is designed specifically for the Tektronix 4010 Series terminals and the 4105 terminal. TCS modules include graphing routines, software character fonts, and graphics tablet support. TCS also provides preview routines for CalComp plotters, enabling on-line, high-speed previewing of plots for large-bed mechanical plotters.

### PLOT 10 Software Terminal Interface (STI)

PLOT 10 STI is a FORTRAN '77 subroutine library for device driver development designed for the Tektronix 4100, 4110, and 4120 Series terminals. Working at a low level and directly accessing terminal firmware features, STI is intended to be used by experienced graphics applications programmers and system programmers. Written in ANSI FORTRAN '77 source code, STI includes sample input/output routines for DEC VAX and IBM hosts, and for Tektronix 6130 Workstations.

### PLOT 10 Graphic Display Interface (GDI)

PLOT 10 GDI is a FORTRAN '77 program which allows graphics applications developed with IBM GDDM to display on Tektronix coax terminals. This is accomplished by translating GDF (Graphics Data Format) file primitives produced by GDDM into Tektronix 4100 display format. Existing GDDM applications, such as the Interactive Chart Utility, are easily displayed on Tektronix coax devices. This allows the user to enjoy the high performance and interactivity of the Tektronix terminals without sacrificing the ability to use existing GDDM applications.

## ORDERING INFORMATION

**Please contact your local sales engineer.**

**Artificial Intelligence: A New Productivity Tool**

Building on the 4404 AI System, Tek now broadens its AI family to include the 4405 with increased processing power and the 4406 with its high speed 16 MHz Motorola 68020 32-bit microprocessor and 68881 co-processor. The Tek AI family offers a powerful range of capabilities for application developers, researchers, software engineers, and computer scientists at prices well below the industry norm.

The 4400's advanced languages make it an excellent exploratory programming and software prototyping tool.

All of the major AI lanaguages in use today are represented on the 4400 including Tek Common LISP, Smalltalk-80, MProlog and Franz LISP. This offers AI researchers and developers a clear choice of programming environments—all accessible from a single desktop device, all fully compatible with the entire 4400 Series Artificial Intelligence Systems.

A quick review of the specifications (see box) clearly shows the preformance of the new 4406 and 4405 is comparable to systems that cost significantly more. AIM expects these new AI systems, based on optimized architecture and powerful, low-cost, general-purpose components, to capture a major portion of emerging AI market because of their outstanding price/performance.

## 4400 SERIES SELECTION GUIDE

| | 4404 | 4405 | 4406 |
|---|---|---|---|
| **Architecture** | 68010 @ 10 MHz<br>Floating point accelerator | 68020 @ 16 MHz<br>68881 Floating point co-processor | 68020 @ 16 MHz<br>68881 Floating point co-processor |
| **Display** | | | |
| Size | 13 inch monochrome | 13 inch monochrome | 19 inch monochrome |
| Viewable Points | 640 x 480 | 640 x 480 | 1280 x 1024 |
| Addressable Points | 1024 x 1024 | 1024 x 1024 | 1024 x 1024 |
| Input Devices | Joydisk, mouse | Joydisk, mouse | Joydisk, mouse |
| **Software** | | | |
| Operating System | UNIX-like OS with 8 MB Virtual memory address space | UNIX-like OS with 32 MB Virtual memory address space | UNIX-like OS with 32 MB Virtual memory address space |
| Languages | | | |
| Standard | Smalltalk-80 | Smalltalk-80 | Smalltalk-80 |
| Optional | Tek Common LISP<br>Franz LISP<br>MProlog | Tek Common LISP<br>Franz LISP<br>MProlog | Tek Common LISP<br>Franz LISP<br>MProlog |
| **Memory** | | | |
| Standard | 1 MB dynamic RAM | 1 MB dynamic RAM | 2 MB dynamic RAM |
| Optional | Additional 3 MB | Additional 4 MB | Additional 4 MB |
| **Communications** | | | |
| Standard | RS-232C<br>Centronics parallel<br>SCSI<br>ANSI X3.64 emulation | RS-232C<br>Centronics parallel<br>SCSI<br>ANSI X3.64 emulation | RS-232C<br>Centronics parallel<br>SCSI<br>ANSI X3.64 emulation |
| Optional | IEEE Ethernet | IEEE Ethernet | IEEE Ethernet |
| **Mass Storage** | | | |
| Standard | 45 MB hard disk<br>5¼ inch, 320 KB flexible (1) | 45 MB hard disk<br>5¼ inch, 320 KB flexible (1) | 90 MB hard disk<br>5¼ inch, 320 KB flexible (1) |
| Optional | 90 MB hard disk & streaming tape drive | 90 MB hard disk & streaming tape drive | 90 MB hard disk & streaming tape drive |
| **Prices Begin At** | $11,950 | $14,950 | $23,950 |

# Artificial Intelligence Systems

- Smalltalk-80 Programming Environment
- 32-Bit CPU
- Floating Point Co-Processor
- Large Dynamic RAM
- Multi-Tasking, Hierarchical File System
- C Compiler with Std. I/O Library
- Several Programming Language Options
- Large Hard Disk, Floppy
- High Resolution Display
- Virtual Memory Operating System
- Three-Button Mouse
- Low Profile Detached Keyboard; 14-Key Numeric Keypad; Four Special, Eight Dedicated Programmable Function Keys; N Key Rollover and Joydisk
- Programmable Sound Generator
- Crystal-Controlled Clock/Calendar with Battery Backup
- ROM/EPROM Expansion Sockets

### 4404 AI System

The Tektronix 4404 Artificial Intelligence System provides a powerful, highly interactive environment for AI research and development. A low-cost desktop system, the 4404 sets a new price/performance standard for AI applications such as expert systems, natural languages, vision systems, theorem proving, intelligent robotics and automatic programming.

The 4404 comes standard with a high-speed, proprietary implementation of Smalltalk-80, an extensible, object-oriented language which supports rapid prototyping and exploratory programming. Smalltalk-80, in conjunction with the 4404 display capabilities, offers the most sophisticated user interface available for AI program development.

A bit-mapped graphics display with mouse input is closely coupled to the processor for a state-of-the-art user-interface. The 13-inch monochrome display has a 640 x 480 pixel resolution and operates at 60 Hz, noninterlaced. It functions as a window into a 1024 x 1024 bit-map memory with smooth panning whenever the cursor reaches a physical display edge. The bit-mapped display facilitates advanced concepts such as overlapping windows, "pop-up" menus and pointing with the mouse. Graphics performance makes screen animation possible. The full keyboard provides programmable function keys and a joydisk.

### *NEW* 4405 AI System

The Tektronix 4405 Artificial Intelligence System joins the Tek 4404 and 4406 to offer a complete family of AI application development toools and delivery systems. The Tek 4405 offers a complete, state-of-the-art, personal AI development system that rivals units costing much more.

Delivering significantly more processing power than the 4404, the 4405 is ideally suited for larger AI efforts. It provides all the software and hardware capabilities needed for developing major artificial intelligence programs.

As with the 4404, the Smalltalk-80 programming environment is included standard with the 4405. This exploratory programming tool offers a highly integrated, object-oriented user interface and is ideal for quick prototyping of complex images. It includes text and graphics editors, incremental compiler, debugging tools and multiple-window management capabilities.

### *NEW* 4406 AI System

The Tektronix 4406 Artificial Intelligence System is the highest performance member in the compatible 4400 Series AI Systems. The 4406 has the power and memory to handle even the most complex AI programs with speed and efficiency. The system includes a 32 Mbyte virtual memory address space, a full 2 Mbytes of dynamic RAM (expandable to 6 Mbytes) and a 90 Mbyte hard disk. The optional 4944 Mass Storage Unit further enhances 4406 performance by providing incremental 90 Mbyte hard disk backup.

The 4406 inherits the innovative design and advanced manufacturing techniques pioneered by the 4404. Employing VLSI architecture and 32-bit data paths, the 4406 is nearly twice as powerful as the 4404. It is equally appropriate for AI research, application development, or as a cost effective delivery system.

### AI Programming Environments

The 4406 supports all of the popular AI programming languages in use today. Smalltalk-80, Tek Common LISP, MProlog, and Franz LISP all run on the 4406. Programs developed on the Tektronix 4404 and 4405 are upwardly compatible with the 4406.

## CHARACTERISTICS

### DISPLAY

**Size** — 330 mm (13 in); [482.6 mm (19 in) 4406 only].

**Viewing Area** — 241 mm x 178 mm (9.5 in x 7 in); [356 mm x 267 mm (14.0 in x 10.5 in) 4406 only].

### MEMORY

**CPU** — Motorola 68020 (68010, 4404 only).

**Floating Point Co-Processor** — Motorola 68881 (National 32081 Semiconductor on 4404).

**Dynamic RAM** — 1 Mbyte (2 Mbyte, 4406 only).

**Terminal Emulation** — ANSI X3.64; 80 characters x 32 lines.

### BIT-MAP RESOLUTION

**Viewable Points** — 640 x 480 (1280 x 1024, 4406 only).

**Addressable Points** — 1024 x 1024 (1280 x 1024, 4406 only).

**Max Baud Rate** — 9600 baud.

**Flexible Disk Capacity** — 320 kB.

**Hard Disk Capacity** —
4404: 45.0 MB.
4405: 45.0 MB.
4406: 90.0 MB.

**Communications Interfaces** — SCSI, RS-232C, Hard Copy.

### AC POWER

**Line Voltage Ranges** — 87 V ac to 128 V ac, 174 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 66 Hz.

**Operating Power** — < 200 W

### PHYSICAL CHARACTERISTICS 4400 CPU MODULES

| | 4404, 4405 | | 4406 | | Mass Storage (All) | |
|---|---|---|---|---|---|---|
| Dimensions | mm | in | mm | in | mm | in |
| Width | 419 | 16.5 | 553.7 | 21.8 | 368.3 | 14.50 |
| Height | 353 | 13.9 | 429.3 | 16.9 | 127.6 | 5.03 |
| Depth | 495 | 19.5 | 566.4 | 22.3 | 433.1 | 17.05 |
| **Weight** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 20.0 | 44.0 | 31.8 | 70.0 | 6.35 | 14.0 |

## ORDERING INFORMATION

**4404** Artificial Intelligence System — **$11,950**
**4405** Artificial Intelligence System — **$14,950**
**4406** Artificial Intelligence System — **$23,950**

### HARDWARE OPTIONS

**Option 01** — 1 MB additional memory (4404 only). — **+$1,750**
**Option 02** — 2 MB additional memory (4405, 4406 only). — **+$3,500**
**Option 03** — 3 MB additional memory (4404 only). — **+$5,250**
**Option 04** — 4 MB additional memory (4405, 4406 only). — **+$7,000**
**Option 10** — Ethernet Interface. — **+$2,000**
**Option 21** — 90 MB Hard Disk — **+$2,500**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 230 V/6 A, 50 Hz.

### SOFTWARE OPTIONS

**4400P30** — Franz LISP Programming Language — **$3,000**
**Option 04** — (4404 only). — **NC**
**Option 05** — (4405 only). — **NC**
**Option 06** — (4406 only). — **NC**

**4400P31** — MProlog Programming Language — **$4,000**
**Option 04** — (4404 only). — **NC**
**Option 05** — (4405 only). — **NC**
**Option 06** — (4406 only). — **NC**

**4400P32** — EMACS Editor — **$500**
**Option 04** — (4404 only). — **NC**
**Option 05** — (4405 only). — **NC**
**Option 06** — (4406 only). — **NC**

**4400P33** — Tek Common LISP Programming Language — **$6,000**
**Option 04** — (4404 only). — **NC**
**Option 05** — (4405 only). — **NC**
**Option 06** — (4406 only). — **NC**

# Smalltalk-80

**Extensible, Object-Oriented Programming**

**Bit-Mapped Graphics User Interface**

**Designed for Exploratory Programming**

Smalltalk combines an object-oriented programming language with the most advanced user-interface available. Pioneered at Xerox PARC, Smalltalk permits exploratory programming through rapid prototyping and experimentation. Smalltalk provides an interactive approach to solving complex problems.

### High Performance Implementation

Tektronix' method of implementing Smalltalk-80 combined with the powerful hardware architecture of the 440 Series, provides graphic response fast enough to support screen animation under direct control of Smalltalk.

Smalltalk satisfies the needs of programmers in the AI field. It is ideal for Artificial Intelligence research and development. Smalltalk can be extended by defining new instances of an object class (each with its own internal state) or by defining an entirely new object class with a distinct set of rules and default behavior. The class structure of Smalltalk provides both multiple inheritance and hierarchical inheritance mechanisms. Over 200 predefined classes support the data and control abstractions most commonly used in AI applications development.

### Original Windowing System

Bit-mapped graphics and window management were originally developed for Smalltalk. The Smalltalk "Model-View-Controller" window-based manager supports the creation of new window-based applications. Multiple processes are supported with a virtually unlimited number of overlapping windows.

Smalltalk supports primitive graphic functions such as scaling, translation, rotation, logical combination of pixels and text attribute modification through its integral "BitBlt" operator.

Virtually any activity—text editing, file manipulation, compilation, execution, debugging—can be performed at any time, regardless of the current state. The user simply "opens" another window and proceeds with the new operation. Smalltalk allows immediate access to any of its subsystems, whether user-defined or predefined, for inspection or modification.

# MPROLOG®

**Configured for 4400 Series AI Systems**

**Interactive Development Support**

**Modular Development Capability**

MProlog, as implemented on the 4400 Series, is a unique language that allows programmers to solve problems by specifying what answers are needed rather than describing a detailed solution procedure. MProlog is non-procedural, based entirely on logical relationships or rules, among an assortment of facts.

MProlog operates on the principle of "controlled deduction." The programmer creates a network of facts and rules that describe the known relationships between the elements of a problem. Once the logical network is defined, MProlog makes logical inferences from the relationships when queried by the programmer. These characteristics make MProlog ideal for many AI applications including expert systems, natural language processing, data base query languages and automatic programming systems.

### Performance for Complex Problems

MProlog makes complex problems easier to solve and reduces program development time. The inherent efficiency of MProlog is enhanced by the power of the 4400 Series hardware. The MProlog system is an ideal vehicle for both software development and end-user AI applications. PROLOG is one of the acknowledged languages in artificial intelligence technology. Now, Tektronix adds the programmer productivity and application development tools needed to move AI into the marketplace.

### ORDERING INFORMATION

**4400P31** MPROLOG Programming Language — **$4,000**

### OPTIONS

**Option 04** — 4404 Version. — **NC**
**Option 05** — 4405 Version. — **NC**
**Option 06** — 4406 Version. — **NC**

# TEK® Common LISP

**A Full Common LISP Implementation**

**Optimized for 4400 Systems**

**Rapid Prototyping of AI Concepts**

**Run-Time Compiler for Optimized Machine Code**

Tek Common LISP has been specifically optimized and enhanced for performance on the Tektronix 4400 Series. It provides AI researchers and software developers with a personal LISP programming environment previously available only on dedicated LISP machines.

Common LISP was conceived by a large committee of academicians and AI researchers as a language that would incorporate the very best features of other LISP dialects. Tek Common LISP is a full implementation of this language (as specified in "Common LISP, The Language" by Guy Steele). It offers a much richer set of data types and more complex program structures than other LISP dialects currently in use.

### A New Standard

Common LISP is considered by many artificial intelligence experts to be a new industry standard for AI programming environments. This consensus is reflected in the general parameters established for the language:

**COMMONALITY:** Common LISP focuses the features of several different implementations of LISP into a common dialect.

**PORTABILITY:** Applications written in Common LISP are easily ported to any Common LISP implementation.

**EXPRESSIVENESS:** Common LISP is a very rich language that employs the most valuable constructs from other LISP dialects.

**EFFICIENCY:** Common LISP has features designed to facilitate the production of fast, high-quality compiled code.

**COMPATIBILITY:** Since Common LISP is derived from a number of popular dialects, code from other LISP dialects should readily map into Common LISP.

### Additional Tek Common LISP Features Include:

A powerful optimizing compiler with built-in debugging features; lexically scoped interpreter and compiler; full featured package system for symbol name differentiation; rich collection of numerical primitives and built-in functions; built-in garbage collector and dynamic storage management; complete implementation of arrays, vectors and strings; flexible interactive user interface; flexible debugging aids; powerful facilities for structures and macros; lexical closures; user-extensible data type facility; and built-in user-extensible data type facility; and built-in user-extensible parser and hash-table facility.

The rich set of primitives available in Common LISP makes the language an appropriate candidate for expert systems, natural language interfaces, and all types of symbolic programming. Tek Common LISP goes beyond the specifications of the language to provide on-line documentation; a user-definable error handler; powerful and robust foreign function interfaces to C and FORTRAN programs and a built-in Flavors system for object-oriented programming.

## ORDERING INFORMATION

**4400P33** Tek Common LISP Programming Language **$6,000**

**OPTIONS**

| | |
|---|---|
| **Option 04** — (4404 only) | **NC** |
| **Option 05** — (4405 only) | **NC** |
| **Option 06** — (4406 only) | **NC** |

### Customer Software Services

Tek Common LISP includes a one-year software update service which can be renewed annually.

# FRANZ LISP

**Configured for 4400 AI Systems**

**Full-Featured Development Language**

**Optimizing Compiler Generates 4400 Series Machine Code**

A commercial derivative of the MacLISP language from MIT, FRANZ LISP is the longtime favorite for AI programming because of its uniqueness as a high-level machine language for symbolic processing. Many natural languages and expert systems have been built using the recursive programming facilities of LISP. Traditionally, LISP has resided only on expensive mainframe computers. Now, Franz LISP is available on the 4400 Series Artificial Intelligence Systems.

### A Powerful AI Programming Environment

4400 Series LISP is a programming environment that includes many tools to enhance research and development. Besides the popular language primitives, functions and data types, LISP contains a powerful macro facility, and allows programs written in other languages to be called. The system supports separately compiled functions, UNIX-like file accessing, and I/O redirection.

Franz LISP supports a wide variety of data types, arithmetic and mapping functions. The language provides dynamic storage allocation and garbage collection. It provides operators for creation, accessing, and manipulation of data types, data type determination, and structure comparison. Users may create their own data types out of vectors and specify how standard system functions, like **print**, should handle them.

Franz LISP provides simple arithmetic functions, arithmetic predicates, trigonometric functions, "bignum" functions and a host of conversion and special purpose arithmetic functions. It includes a set of operators to allow dynamic error indication and recovery, with nonstandard control flows, through the powerful **catch, throw** and **errset** functions.

Franz LISP in the 4404 environment provides many functions for communicating with I/O devices, including I/O redirection to and from files. It supports UNIX-like disk file operations such as direct file access with the **fseek** function, allowing reading or writing at random locations within a file.

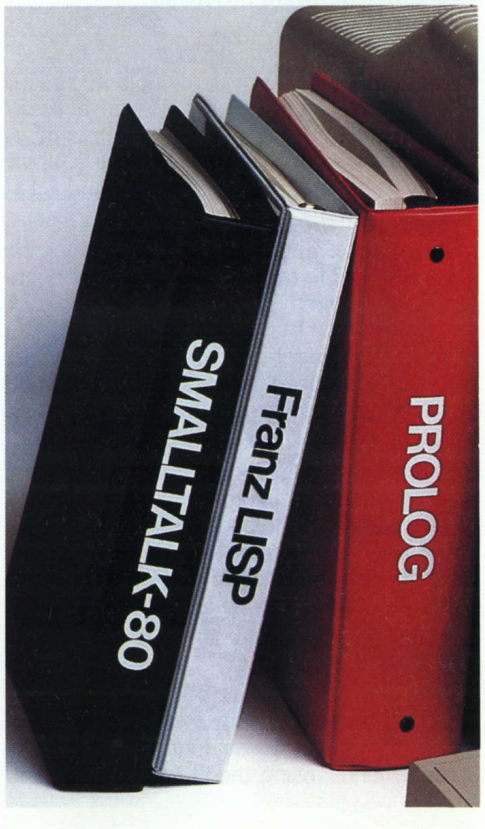
Many system functions allow interaction with internal components of LISP and the operating system. These include new process generation from within a program with the process and signal functions.

## ORDERING INFORMATION

**4400P30** FRANZ LISP Programming Language **$3,000**

**OPTIONS**

| | |
|---|---|
| **Option 02** — 5¼ Floppy Media | **NC** |
| **Option 04** — (4404 only). | **NC** |
| **Option 05** — (4405 only). | **NC** |
| **Option 06** — (4406 only). | **NC** |



# 4991S1 Graphic Input Workstation

**A Complete Graphic Input Solution**

**Offers up to Ten-Fold Productivity Increase over Manual Digitizing or On-Screen Redesign**

**Transfers Data from Hard-Copy Documents into CAD Systems**

**Automatic Scanning and Vectorizing of Documents**

**Interactive Software Produces Graphics Entities**

The Tektronix 4991S1 quickly and accurately transforms existing documents into a useful data base for CAD systems. It supports many applications in mechanical engineering, architecture, mapping, and electrical engineering.

The 4991S1 supplies useful data with minimum impact on host CAD system resources. The 4991S1 interfaces directly to three leading CAD systems: ComputerVision, CADAM, and TekniCAD. The direct interface ensures rapid, accurate data transfer. Because scanning and structuring processes are performed locally, CAD system resources are not tied up with time consuming input tasks.

The interactive Graphic Structuring Software gives the user maximum flexibility and control in preparing the most usable data base for any given application. The structuring software supports a variety of entities (e.g., lines, arcs, text, symbols), standard attributes (e.g., line width, line style), and user-definable attributes.

A straightforward user interface simplifies scanning and structuring by allowing the operator to control most functions from on-screen menus, using the graphics tablet and stylus. A clear, accurate, and complete documentation package, including an on-line tutorial, makes the workstation surprisingly easy to learn and use.

## CHARACTERISTICS
### (4991 SYSTEM)
### SYSTEM POWER REQUIREMENTS

**Total Power Consumption** — 1381 Watts. (4991: 275 W. 4991WS Electronics Module: 872 W. 4991WS Display Module: 230 W. 4957: 4 W.)

**Line Voltage Ranges** — 87 V ac-128 V ac or 174 V ac-250 V ac.

**Line Frequency** — 50 Hz or 60 Hz nominal (±2 Hz).

### PHYSICAL CHARACTERISTICS

| | 4991 | | 4991WS w/Display & Table | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 1219 | 48.0 | 1505 | 59.3 |
| Height | 1283 | 50.5 | 1118 | 44.0 |
| Depth | 787 | 31.0 | 914 | 36.0 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 150.0 | 330.0 | 152.1 | 335.0 |
| Shipping | 225.0 | 495.0 | 258.1 | 546.0 |

### PERFORMANCE

**Scanning Technology** — Precision drum scanner; halogen lamp illumination and Charge Coupled Device Array detector.

**Maximum Scan Area** — 885 mm x 1200 mm (34.8 in x 47.2 in).

**Resolution** — 12 samples/mm (304.8 samples/in).

**Typical Media** — Black graphite lead or black ink on vellum; black plastic lead or black ink on drafting film; photographic line art; bluelines.

**Minimum Line Detected** — (with contrast >0.5) 0.254 mm (0.010 in).

**Programmable Features** — User-definable scan area; dot and void removal; edge smoothing, line fitting accuracy; digitizing threshold; document rotation; mirror image.

**Output Capabilities** — Hardware: RS-232C, 19.2 kbaud. Protocol: KERMIT-type communications protocol. Modes: Freeman code data, polynode data, interconnect data, combined data. User-selectable output data files: polylines, short vectors, and filled areas.

### CHARACTERISTICS (4991WS)

**Data Transmission** — RS-232C, 19.2 kbaud.

**Memory** — 2.0 Mbytes RAM with ECC; 20 Mbytes internal hard disk.

**Display** — 483 mm (19 in) diagonal color raster; 60 Hz, noninterlaced.

**Graphics** — 1024 x 1280 pixels.

### CHARACTERISTICS (GRAPHIC STRUCTURING SOFTWARE)
#### Functional Structuring Capabilities

**Graphics Entities Supported** — Lines, polylines, arcs, circles, text, symbols, ellipses, arrows, dimensions, splines.

**Attributes Supported** — Layer number, pen number, color, line width, line style, text font, character slant, arrow style, user-definable attributes.

**Transformation Operations** — N-point alignment, snap-to-grid.

**Viewing Capabilities** — Zoom, pan, previous view, original view, nodes.

**Local Calculations** — Position, distance, user-defined units.

**Host Control and Interfacing** — KERMIT-type communications protocol.

### PERFORMANCE

**Capacity** — 98,000 nodes (larger drawings are managed by structuring smaller sections of the original file).

### CHARACTERISTICS (HOST INTERFACING SOFTWARE)

**Data Communications** — KERMIT-type protocol.

**Data Conversion** — 4991S1 to IBM CADAM Version 19.2.4 or later (MVS/TSO and CM/VMS). 4991S1 to Computervision CADDS 4X. 4991S1 to Tektronix PLOT 10 Computer-Aided Drafting (TekniCAD) Version 7.3 or later.

**Data Checking** — Unrecognized or illegal host system commands or data reported on the 4125 display for immediate correction.

**Configuration** — Host-system resident.

**Language** — FORTRAN IV (license required).

### PHYSICAL CHARACTERISTICS

**Media** — Nine-track magnetic tape (1600 bpi).

**Format** — Block 80 x 10, standard label EBCDIC and unlabeled ASCII.

## ORDERING INFORMATION

**4991S1** Graphic Input Workstation **150,000**
**Includes:** 4991WS (4125 Color Graphics Workstation); 4100P 01 with Option 01 and Option 11: CP/M-86 +DTI: 4100H 01 Workstation table; 4957 Graphics tablet; 4991 Auto Vectorizer; 4991P 01 Graphic structuring software.

#### OPTIONS

**Option 01** — 4991P02, CADAM HIS. **+12,000**
**Option 02** — 4991P03, ComputerVision HIS. **+12,000**
**Option 05** — Add Option 05 to 4991WS. **+12,195**

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

#### *WARRANTY-PLUS* SERVICE PLAN
SEE PAGE 457

**N1** — Service Plan + 9 Months Service. **+$4,450**
**N3** — OEM Service Plan +12 Months Service. **+$5,930**

**Initially available within the U.S. only. Contact your nearest sales office for availability in your area.**

**OEM terms available on this product.**

**Flexible leasing programs available in the continental U.S.**

*The 4691, 4692 and 4695 Color Graphics Copiers offer high-quality transparency and plain paper copies.*

## A Family of Copiers

The 4690 Family of color graphics copiers consists of the 4695 high quality, personal color copier; the 4692 very high quality A-size color copier and the 4691 very high quality A and B size color copier.

The 4695 provides unprecedented image quality in its price range.

Where higher speeds, automatic media handling and standard A/A4 size output are required, the 4692 will be the preferred solution. Multiplexing lowers the cost per user.

Specially matched paper, transparency film and ink result in 4692 copies of the brightest, most highly saturated colors available outside of color photography. Business graphics, scientific data, maps or mechanical drawings may be copied from the terminal screen in rich, true colors.

For complex images such as geometric models or maps, the B-size copies of the 4691 provide the detail needed.

For full resolution graphics images, you will find the 4510A hardware rasterizer from Tektronix an invaluable companion to a Tektronix 4691, 4692 or 4695 Color Graphics Copier. Connecting the 4510A Color Graphics Rasterizer between a host or terminal and any of Tek's color copiers, you can copy a drawing, map, or graph at the full resolution of the copier in 256 solid and halftoned colors out of a palette of over 132,000.

## COLOR COPIER/RASTERIZER SELECTION GUIDE

| | 4691 Copier | 4692 Copier | 4695 Copier | 4510A Rasterizer |
|---|---|---|---|---|
| **Addressability** | | | | |
| Fixed Horiz/Vert | 6 dots/mm (150 dots/in) | 6 dots/mm (150 dots/in) | 4 dots/mm (120 dots/in) | |
| Variable Preview Horiz/Vert | | 128 to 158 dots/in | | 32 bit |
| **Copy Time** | 2.0 min to 3.5 min | 1.0 min to 3.0 min | 2 min to 3.5 min (4105)<br>3 min to 5.25 min 4106/7/9<br>6 min to 8.5 min (4113)<br>8.5 min to 17.5 min (4115B) | 2 min (4691, 4692)<br>3 min to 5 min (4695) |
| **Printing Speed** | - | - | 20 characters/s | - |
| **Character Set** | - | - | Full ASCII | - |
| **Printing Matrix** | - | - | 12 x 16 dot matrix | - |
| **Page and Image Format** | | | | |
| B | Yes | | | Yes |
| A | Yes | Yes | Yes | Yes |
| A3 | Optional | | | Yes |
| A4 | Yes | Optional | Yes | Yes |
| Landscape/Portrait Format Selectable | Yes | Yes | Yes | Yes |
| **Colors** | 8 | 216 colors/shades | 8 | 274,625 selectable* |
| **Media Types** | | | | |
| Paper Sheet | Yes | Yes | Yes | - |
| Overhead Transparencies | Yes | Yes | Yes | - |
| Paper Roll | - | - | Yes | - |
| **Interface** | 8-Bit Parallel | 8-Bit Parallel | 8-Bit Parallel | RS-232 in, 8-bit 8-Bit Parallel |
| **Data Rate** | Up to 400 kbytes | Up to 400 kbytes | | 75 to 19,200 baud |
| **4104/5/A** | Yes | Yes | Yes | - |
| **4113/15B** | Yes | Yes | Yes | Yes |
| **4125/8/9** | Yes | Yes | Yes | Yes |
| **4510A** | Yes | Yes | Yes | Yes |
| **4691** | - | - | - | Yes |
| **4692** | - | - | - | Yes |
| **4695** | - | - | - | Yes |

| **Dimensions** | mm | in | mm | in | mm | in | mm | in |
|---|---|---|---|---|---|---|---|---|
| Width | 608 | 23.9 | 610 | 24.0 | 500 | 19.7 | 406 | 16.0 |
| Height | 346 | 13.5 | 216 | 8.5 | 151 | 5.9 | 135 | 5.3 |
| Depth | 821 | 32.3 | 610 | 24.0 | 336 | 13.2 | 478 | 18.8 |
| **Weight** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 60 | 132.0 | 32 | 70.0 | 11.0 | 24.2 | 7.0 | 15.5 |
| **Page** | 77 | | 76 | | 77 | | 76 | |
| **Prices Begin At** | $10,950 | | $7,995 | | $1,595 | | $4,495 | |

** 256 printable per image.*

## 4692 Color Graphics Copier

**Superior Image Quality and Excellent Color Saturation**

**Unique Ink Transient Suppressor for Reliable Operation**

**Adjustable for A and A4 Size**

**Horizontal and Vertical Formats**

**Four-Channel Multiplexer I/F Option**

**Variable Image Density and Copy Time**

**216 On-Board Colors**

**Complete Supplies Start-Up Kit**

**Auto-Handling of Paper and Transparencies**

**The Tek 4692 Color Graphics Copier Offers High-Quality A and A-4 Size Color Copying from 4100, 4110 and 4120 Series Color Display Terminals or Host System. Both Connections Can be Enhanced with the Tek 4510 Color Graphics Rasterizer.**

The 4692 represents a new standard in color ink-jet reliability. The high performance drop-on-demand air flow technology provides addressability of up to 1536 by 1152 dots in an A-size image. Specially matched paper and transparency media and inks provide highly saturated colors (including vivid black due to a separate black ink supply.)

Each ink-jet head is backed by a unique Ink Transient Suppressor (patent pending) that effectively prevents the ink clogs and bubbles associated with some ink-jet printers.

## CHARACTERISTICS

**Addressability** — Fixed Mode Vertical and Horizontal: 6 dots/mm (154 dots/in). Variable "preview" mode vertical and horizontal 128 dots/in to 158 dots/in.

**Copy Time** — One minute to three minutes (depending on image format, addressability mode, and the signal source).

**Page and Image Format** — A and A4 output sizes. Landscape and portrait format selectable under program control.

**Image Sizes** — Variable depending on orientation and image source (for A-size output; A4-size output slighty smaller to maintain adequate margins).

**Color** — 216 on-board colors and shades.

**Media Types** — Paper sheet, overhead transparency.

**Compatibility** — 4104A/5A/6A/7A/9A/CX, 4113B/15B Option 19, 4125/8/9 Option 19 Computer Display Terminals, 4510A Color Graphics Rasterizer.

**Interface** — Eight-bit parallel.

**Data Rate** — Up to 400 kbytes (burst mode).

## ORDERING INFORMATION

**4692*** Color Graphics Copier **$7,795**

**OPTIONS**

**Option 01** — Set-up for A4 Size Media. **NC**
**Option 02** — Four-Channel Multiplexer. **+995**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

**N0** — Installation & Set-up **+$200**
**N1** — Service Plan + 9 Months Service. **+$640**
**N3** — OEM Service Plan + 12 Months Service. **+$300**

** The 4692 must be ordered with Installation Option N0.*

## *NEW* 4510A

### Color Graphics Rasterizer

**Full Resolution Output to Tek 4691, 4692, and 4695 Color Graphics Copiers**

**Compatible with Tek 4100, 4110, and 4120 (2D Capability) Series Color Display Terminals**

**Shared System Resource**

**More than 274,000 Selectable Colors**

**Tek 4100 Series Command Set**

**The 4510A Color Graphics Rasterizer enhances the copy quality of the 4691, 4692 and 4695 Color Graphics Copiers by converting vector images into raster format.** The result is hardcopy at the full resolution of the copier, rather than output limited to the resolution of the terminal. Blurred charcters become crisp, jagged lines become smooth, even E-size engineering drawings can be legibly printed on B-size paper from the 4691. The 4510A also expands the color palette for the 4691, 4692 and 4695 to over 274,000 selectable colors.

## ORDERING INFORMATION

**4510A*** Color Graphics Rasterizer **$3,500**

**OPTIONS**

**Option 30*** — 128 kbytes total memory. (Capacity: Approximately 12,000 vectors). **+$995**
**Option 31*** — 512 kbytes total memory. (Capacity: Approximately 50,000 vectors). **+$2,495**
**Option 32*** — 2 Mbytes total memory. (Capacity: Approximately 200,000 vectors). **+$6,495**

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

**N0** — Installation & Set-up **+$120**
**N1** — Service Plan + 9 Months Service. **+$85**
**N3** — OEM Service Plan + 12 Months Service. **$115**

** The 4510A must be ordered with a memory option.*

**Flexible leasing programs available in the continental U.S.**

## 4691 Color Graphics Copier

**High Image Quality and Excellent Color Saturation**

**Adjustable for A and B Size**

**Landscape and Portrait Formats**

**Clear Transparency Capability**

**Four-Way Multiplexer Option**

**Compatible with Tek 4100, 4110, and 4120 Series Color Display Terminals**

**Full Resolution Hard Copies From R4510A Color Graphics Rasterizer**

**Color Match-To-Screen Via Option 19 on 4110 and 4120 Series Graphics Terminals**

Copies can be made in A size (8.5 in x 11 in) or B size (11 in x 17 in) and their metric equivalents, in as little as two to three and a half minutes. The high performance drop-on-demand ink-jet technology provides addressability of six dots per mm (150 dots per inch) in both horizontal and vertical directions. This allows up to 1560 x 2460 points in a B size image and up to 1560 x 1200 points in an A size image. Full resolution B-size copies are particularly suited for complex engineering drawings. For best B-size quality, it is recommended the 4691 be used with the *NEW* 4510A Color Graphics Rasterizer.

### ORDERING INFORMATION

**4691** Color Graphics Copier **$10,950**

**Includes:** 500 sheets (B size and A3 size when Opt 01 is ordered) ink-jet copy paper (016-0711-00); 200 ml capacity each ink-jet cartridges, cyan (016-0713-00); black (016-0714-00); yellow (016-0715-00); magenta (016-0716-00); 10 ft interconnecting cable 3 meters (012-0518-00); power cable (161-0104-00); "A" and "B" Size (Standard) paper tray (118-2557-00); "A3" and "A4" Size (if Option 01 is ordered) paper tray (118-2556-00); 3/pkg drum adaptors (118-2593-00); operator manual (070-4500-00).

**OPTIONS**

**Option 01** — Set-up for A3 Size Output. **NC**
**Option 02** — Four Channel Multiplexer. **+$1,200**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 458**

**N0** — Installation and Set-up. **NC**
**N1** — Service Plan + 9 Months Service. **NC**
**N3** — OEM Service Plan + 12 Months Service. **NC**

## 4695 Color Graphics Copier

**Unprecedented Image Quality in its Price Range**

**Clear Transparency Capability**

**Quiet, 20 Character/Second Printing**

**Small, Compact Package**

**Choice of Roll or Sheet Paper**

**Full Resolution Hard Copies From A4510A**

**Color Match-To-Screen Via Option 19 on 4110 and 4120 Series Graphics Terminals**

**The 4695 Color Graphics Copier Provides Low Cost, High Performance Color Copying from the 4100, 4110 and 4120 Series Color Display Terminals and Other Raster Data Sources**

The 4695's unique implementation of drop-on-demand ink-jet technology provides addressability of 4.8 dots per mm (120 dots per inch) in both horizontal and vertical directions. This allows up to 1280 points x 960 points per A size (8½ in x 11 in) image.

### ORDERING INFORMATION

**4695** Color Graphics Copier **$1,595**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 458**

**N0** — Installation and Set-up. **+$125**
**N1** — Service Plan + 9 Months Service. **+$430**
**N3** — OEM Service Plan + 12 Months Service. **+$570**

**Flexible leasing programs available in the continental U.S.**

## 4612 Video Hard Copy Unit

**Low Copy Cost**

**High Contrast, Black and White Images**

**Electrostatic Process**

**Video Source Compatibilities**

Hard copy units such as the 4612 provide quick and convenient copies of complex information that has been displayed on a screen. These devices are essential to the use of graphic terminals, desktop computing systems, and video image processing systems. To fulfill a variety of user needs, graphic and alphanumeric information is permanently recorded on paper at the press of a button. These needs include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records.

### CHARACTERISTICS

**Warm-up Time** — Two minutes.
**Copy Time** — 24 s.
**Paper Type** — Electrographic (dielectric).
**Image Size** — 7.5 x 5.8 std (525 line, 60 Hz signals).
**Addressability** — Horizontal: 256 dots/in. Vertical: 171 dots/in.
**Toner** — Dry magnetic.

#### AC POWER

**Voltage Range** — 90 V ac to 128 V ac and 180 V ac to 250 V ac. (High range requires Options A1, A2, A3 or A4.)
**Warm-up** — 300 W nominal, 360 W maximum.
**Copy Process** — 215 W nominal, 290 W maximum.
**Idle** — 120 W nominal, 185 W maximum.

### ORDERING INFORMATION

| | |
|---|---|
| **4612** Video Hard Copy Unit | **$5,565** |
| **OPTIONS** | |
| **Option 02** — Four Channel Multiplexer. | **+$990** |
| **Option 03** — Set-up for 625/50 Hz Scanning Std. | **NC** |
| **Option 08** — Set-up for DEC VT100 Series Terminals. | **NC** |
| **INTERNATIONAL POWER PLUG OPTIONS** | |
| **Option A1** — Universal Euro 220 V/16 A, 50 Hz. | |
| **Option A2** — UK 240 V/13 A, 50 Hz. | |
| **Option A3** — Australian 240 V/10 A, 50 Hz. | |
| **Option A4** — North American 240 V/15 A, 60 Hz. | |
| **Option A5** — Switzerland 220 V/10 A, 50 Hz. | |
| ***WARRANTY-PLUS* SERVICE PLANS** **SEE PAGE 457** | |
| **N0** — Installation & Service. | **+$150** |
| **N1** — Service Plan + 9 Months Service. | **+$515** |
| **N3** — OEM Service Plan + 12 Months Service. | **+$685** |

## 4632 Video Hard Copy Unit

**Copies in Seconds**

**Gray Scale Capability**

**Copies Many Color Display**

**Video Source Compatible**

The 4632 provides very fast, photographic quality hard copies from color raster scan terminals such as the Tektronix 4109A and 4120 Series. First, copies are produced in 18 seconds regardless of the complexity of the screen image. Copies feature a minimum of six continuous shades of gray.

### CHARACTERISTICS

**Copy Time** — 18 s first copy; 9 s subsequent copies.
**Gray Shades** — Six minimum (8 w/Option 06).
**Addressability** — Incoming signal dependent.
**Image Size** — 203 mm x 152 mm (8 in x 6 in).
**Paper** — Size: 216 mm x 277 mm (8.5 in x 11 in). Type: Standard Dry Silver (500 ft roll).
**Warm-up Time** — 10 minutes.

#### AC POWER

**Voltage Range, Standard** — 104 V ac to 126 V ac.
**Strappable** — Low Range: 90 V ac to 110 V ac. High Range: 108 V ac to 132 V ac.
**Warm-up** — 620 W nominal; 240 W maximum.
**Copy Process** — 200 W nonimal; 240 W maximum.
**Idle** — 120 W nominal, 185 W maximum.

### ORDERING INFORMATION

| | |
|---|---|
| **4632** Video Hard Copy Unit | **$6,800** |
| **OPTIONS** | |
| **Option 01** — Copy Counter. | **+$200** |
| **Option 02** — Four Channel Multiplexer. | **+$990** |
| **Option 03** — Set-up for 625 Line/50 Hz. | **NC** |
| **Option 04** — Set-up 1029 Line/60 Hz. | **NC** |
| **Option 05** — Set-up for Tektronix 4023 Terminal. | **NC** |
| **Option 06** — Enhanced Gray Scale. | **+$970** |
| **Option 07** — Compatible with HP 2640 Series Terminals. | **+$150** |
| **Option 08** — Compatible with DEC MINC Systems. | **+$150** |
| **Option 09** — Set-up for AT&T GEMINI 100 Systems. | **+$150** |
| **Option 10** — Set-up for Tek 4109A. | **NC** |
| **016-0596-00** — RGB Mixer. | **+$425** |
| **INTERNATIONAL POWER PLUG OPTIONS** | |
| **Option A1** — Universal Euro 220 V/16 A, 50 Hz. | |
| **Option A2** — UK 240 V/13 A, 50 Hz. | |
| **Option A3** — Australian 240 V/10 A, 50 Hz. | |
| **Option A4** — North American 240 V/15 A, 60 Hz. | |
| **Option A5** — Switzerland 220 V/10 A, 50 Hz. | |
| ***WARRANTY-PLUS* SERVICE PLANS** **SEE PAGE 457** | |
| **N0** — Installation & Service. | **+$175** |
| **N1** — Service Plan + 9 Months Service. | **+$600** |
| **N3** — OEM Service Plan + 12. | **+$800** |

## 4631 Hard Copy Unit

**High Image Quality, Copies in Seconds**

**Fiber Optic Process**

**Storage Tube Compatible**

The 4631 Hard Copy Unit provides superior quality copies of any graphic and alphanumeric information displayed on a storage tube display. The 4631's fiber optic process uses Dry Silver paper for the fine detail and photographic quality image.

### CHARACTERISTICS

**Normal Scan** — 18 s first copy; 9 s subsequent.
**Slow Scan** — 36 s first copy; 16 s subsequent.
**Paper Size** — 216 mm x 277 mm (8.5 in x 11 in).
**Paper Type** — Std Dry Silver (500 ft roll).
**Addressability, Normal Scan** — Vertical: 79 dots/cm (200/in). Horizontal: 67 dots/cm (170/in).
**Slow Scan** — Vertical: 118 dots/cm (300/in). Horizontal; 134 dots/cm (340/in).
**Image Size** — Vertical Format: 180 mm x 137 mm (7.1 in x 5.4 in). Horizontal Format: 225 mm x 170 mm (8.85 in x 6.7 in). Option 31: 163 mm x 190 mm (6.4 in x 7.5 in).
**Warm-up Time** — Ten minutes.

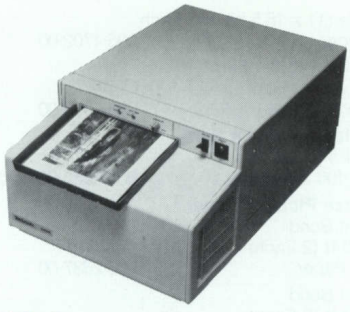
#### AC POWER

**Voltage Range, Standard** — 104 V ac to 126 V ac.
**Strappable Low Range** — 90 v ac to 126 V ac.
**Strappable High Range** — 108 V ac to 132 V ac.
**Power, Warm-up** — 620 W nominal; 750 W on high range.
**Power, Copy Process** — 200 W nominal; 240 W on high range.

### ORDERING INFORMATION

| | |
|---|---|
| **4631** Hard Copy Unit | **$7,150** |
| **OPTIONS** | |
| **Option 01** — Copy Counter. | **+$200** |
| **Option 02** — Four Channel Multiplexer. | **+$990** |
| **Option 31** — Compatible with Tektronix 4025 and 4025A Terminal. | **NC** |
| **INTERNATIONAL POWER PLUG OPTIONS** | |
| **Option A1** — Universal Euro 220 V/16 A, 50 Hz. | |
| **Option A2** — UK 240 V/13 A, 50 Hz. | |
| **Option A3** — Australian 240 V/10 A, 50 Hz. | |
| **Option A4** — North American 240 V/15 A, 60 Hz. | |
| **Option A5** — Switzerland 220 V/10 A, 50 Hz. | |
| ***WARRANTY-PLUS* SERVICE PLANS** **SEE PAGE 457** | |
| **N0** — Installation & Service. | **+$175** |
| **N1** — Service Plan + 9 Months Service. | **+$600** |
| **N3** — OEM Service Plan + 12 Months Service. | **+$800** |

**Flexible leasing programs available in the continental U.S.**



## 4634 Imaging Hard Copy Unit

**Fast, High Resolution Copier for Tek and Other Terminals**

**Excellent Gray Scale**

The 4634 provides fast, photographic quality hard copies from both Tektronix color graphics terminals and other TV video sources, both analog and digital. First copies are produced in 26 seconds, successive copies in 12 seconds, regardless of the complexity of the screen image. Hard copies feature a minimum of 12 continuous shades of gray when made with high performance paper. The 4634 is particularly suited for solids modeling and other CAD applications.

### CHARACTERISTICS

**Copy Time** — 26 s first copy; 12 s subsequent copy.

**Gray Shades** — At least 12 w/high performance paper; at least 6 with standard paper.

**Resolution** — At least 4.92 lines/mm (125 lines/in) with high performance (7772) paper; at least 3.94 lines/mm (100/lines/in) with standard (7770) paper.

**Horizontal Image Size Range** — 127 mm to 203 mm (5 in to 8 in) for 60 Hz field rate; 152 mm to 203 mm (6 in to 8 in) for 50 Hz field.

**Vertical Image Size Range** — Adjusts for correct aspect ratio.

**Recording Medium** — Dry Silver Paper; Tektronix' High Performance (7772) Paper or switch selectable to Tektronix' Standard (7770) Paper.

**Paper Dimensions** — 216 mm x 152 m (8.5 in x 500 ft).

**Warm-up Time** — 20 minutes.

#### AC POWER

**Line Voltage Range (±10%)** — Jumper selectable for 100 V ac, 120 V ac, 220 V ac, 230 V ac, and 240 V ac.

**Line Frequency** — 48 Hz to 62 Hz.

### ORDERING INFORMATION

**4634** Imaging Hard Copy Unit **$8,300**

**OPTIONS**

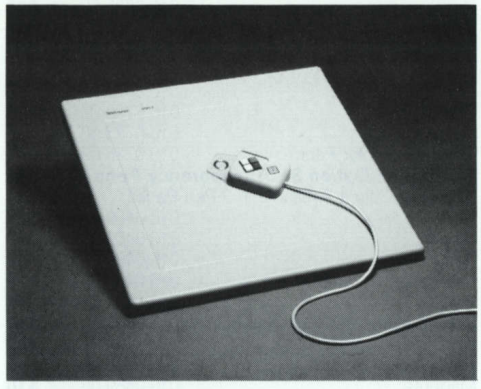
**Option 09** — Set-up for Tek 4109A. **NC**
**Option 15** — Set-up for Tek 4120 Series. **NC**
**Option 30** — Delete Rackmount Hardware. **−$85**
**Option 45** — End-User Configuration. **NC**
**016-0596-00** — RGB Mixer. **+$425**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

**N1** — Service Plan + 9 Months Service. **+$600**
**N3** — OEM Service Plan + 12 Months Service. **+$800**



## 4957 Graphics Tablet

**Graphic Input Capabilities for 4100 and 4110 Computer Display Terminals**

**RS-232C Compatible**

### Simple Four-Button Cursor Control

To use the 4957, merely touch the four-button cursor-puck to the tablet's active area. The tablet calculates the coordinates and relays them to the host computer for storage or manipulation.

### Applications Fit

The 4957 can augment a terminal keyboard as a menu selection device, move a cursor around a display screen, or help transfer data from paper to a computerized data base.

### Compatibility

The 4957 is compatible with the Tek 4106A, 4107A, 4109A and 4110A Family of computer display terminals.

### CHARACTERISTICS

**Size** — 419 mm x 394 mm (16.5 in x 15.5 in).

**Active Writing Area** — 297 mm x 297 mm (11.7 in x 11.7 in).

**Resolution*[1]** — User selectable up to 1000 points/inch.

**Speed*[1]** — User selectable up to 90 coordinates/second.

**Accuracy** — ±.625 mm (0.025 in).

**Repeatability** — ±.250 mm (0.010 in).

*[1] *Maximum specs may not be accessible from various terminals.*

### ORDERING INFORMATION

**4957** Graphics Tablet **$955**

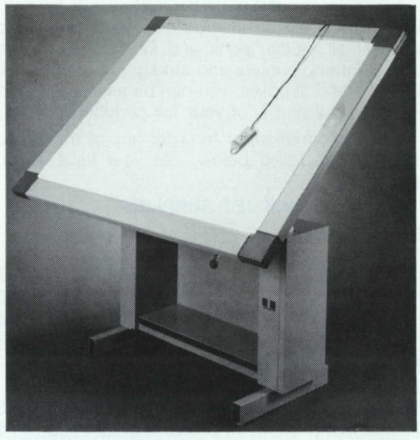
**Includes:** Power supply and cord (119-1748-00); four-button cursor (119-1775-00); operator manual (070-4784-00).

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

**N1** — Service Plan + 9 Months Service. **+$45**
**N3** — OEM Service Plan + 12 Months Service. **+$55**



## *NEW* 4958 Graphics Tablet

**Highly Precise, Easy-to-Use Graphic Input Capabilities for the 411X Series Computer Display Terminals, the 412X Series Color Graphics Workstations and RS-232 Based Computers**

### Desktop or Pedestal Configurations

The 4958 is available in either 17 x 24 inch desktop, 36 x 48 inch pedestal-compatible, or 44 x 60 inch pedestal-compatible configurations.

### Simple, Flexible Input

The 4958 reads graphic coordinate data via a multi-button cursor or a stylus. When either is touched to the tablet surface, the tablet calculates the coordinates and relays them to the host computer/terminal for further processing.

### Programmability

The tablet cursor is available with either 4 or 16 buttons and has a fine cross-hair lens for accurate point selection. The cursor serves as a programmable hand-held keyboard from which the user can perform user-defined functions at the touch of a button.

### High Resolution for Precision Duplication

To faithfully duplicate precision drawings the 4958 offers up to 1,000-points-per-inch resolution with 0.010 inch accuracy.

### ORDERING INFORMATION

**4958** Graphics Tablet (Option Required) **$500**
**Option 03** — (17 x 24"). **+$4,000**
**Option 05** — (36 x 48"). **+$6,450**
**Option 06** — (44 x 60"). **+$8,750**
**Includes:** Power supply and cord (119-1748-00); four-button cursor (119-1775-00); and user's manual.

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

***WARRANTY-PLUS* SERVICE PLANS**
**SEE PAGE 457**

**N1** — Service Plan + 9 Months Service. **+$300**
**N3** — OEM Service Plan + 12 Months Service. **+$400**

**Flexible leasing programs available in the continental U.S.**

## INTRODUCTION

Now you can rely on Tektronix as your single supply source for all media, pens and ink for your Tektronix copiers, plotters, printers and storage devices. By using Tektronix brand supplies, you can be assured of getting the best output quality of your Tek peripherals.

For further information, or to order any of the Tektronix brand supplies listed below, call your local Tektronix sales office.

## INK JET SUPPLIES

**4691 Ink Cartridges**
200 ml Each

| | | |
|---|---|---|
| Cyan | 016-0713-00 | $85 |
| Black | 016-0714-00 | $85 |
| Yellow | 016-0715-00 | $85 |
| Magenta | 016-0716-00 | $85 |

**4691 Ink Jet Copy Paper**
500 Sheets Per Package

| | | |
|---|---|---|
| 216 x 279 mm (8.5 x 11 in) A Size | 016-0712-00 | $25 |
| 279 x 432 mm (11 x 17 in) B Size | 016-0711-00 | $40 |
| 210 x 297 mm (only for use with 4691 Option 01) A4 Size | 016-0709-00 | $25 |
| 297 x 420 mm (only for use with 4691 Option 01) A3 Size | 016-0710-00 | $40 |

**4691 Transparency Film**
100 Sheets Per Package

| | | |
|---|---|---|
| A Size | 016-0765-00 | $90 |
| A4 Size | 016-0766-00 | $90 |

**4691 Drum Adaptors**

| | | |
|---|---|---|
| Package of 3 for use with A or A4 size | 118-2593-00 | $15 |

**4692 Ink Cartridges**
200 ml Each

| | | |
|---|---|---|
| Cyan | 016-0713-01 | $85 |
| Black | 016-0714-01 | $85 |
| Yellow | 016-0715-01 | $85 |
| Magenta | 016-0716-02 | $85 |

**4692 Ink Jet Copy Paper**
500 Sheets Per Package

| | | |
|---|---|---|
| 216 x 279 mm (8.5 x 11 in) A Size | 016-0793-00 | $35 |
| 210 x 297 mm A4 Size | 016-0794-00 | $35 |

**4692 Transparency Film**
100 Sheets Per Package

| | | |
|---|---|---|
| A Size | 016-0765-02 | $90 |
| A4 Size | 016-0766-02 | $90 |

**4692 Maintenance Cartridge**

| | | |
|---|---|---|
| 250 ml | 016-0770-02 | $36 |

**4695 Ink Cartridge Packages**
2.5 cc Each, 16 Per Package

| | | |
|---|---|---|
| Yellow | 016-0734-00 | $27 |
| Magenta | 016-0735-00 | $27 |
| Cyan | 016-0736-00 | $27 |
| Black | 016-0737-00 | $27 |

**4695 Ink Jet Copy Paper**
50 m Each 6 Rolls Per Box

| | | |
|---|---|---|
| Roll Paper | 016-0743-00 | $70 |

**4695 Ink Jet Copy Paper**
500 Sheets Per Package

| | | |
|---|---|---|
| A Size | 016-0739-00 | $35 |
| A4 Size | 016-0740-00 | $35 |

**4695 Transparency Film**

| | | |
|---|---|---|
| 100 Sheets Per Package | 016-0480-00 | $85 |

**4695 Liquids**

| | | |
|---|---|---|
| Maintenance Liquid (200 cc) | 016-0732-00 | $10 |
| Print Head Protect Liquid (10 cc) | 016-0733-00 | $6.00 |

## PLOTTER PENS

**4663, 4662 Option 31 Paper Pens**
Regular Width
Individual Colors Available in 3-Pen Packages.

| | | |
|---|---|---|
| Black | 016-0414-00 | $8.00 |
| Brown | 016-0414-01 | $8.00 |
| Red | 016-0414-02 | $8.00 |
| Orange | 016-0414-03 | $8.00 |
| Yellow | 016-0414-04 | $8.00 |
| Green | 016-0414-05 | $8.00 |
| Blue | 016-0414-06 | $8.00 |
| Purple | 016-0414-07 | $8.00 |
| Magenta | 016-0414-08 | $8.00 |
| 9-Pen Multicolor Pack | 016-0414-09 | $25 |

**4663, 4662 Option 31 Paper Pens**
Fine Line
Individual Colors Available in 3-Pen Packages.

| | | |
|---|---|---|
| Black | 016-0725-00 | $18 |
| Brown | 016-0725-01 | $18 |
| Red | 016-0725-02 | $18 |
| Orange | 016-0725-03 | $18 |
| Yellow | 016-0725-04 | $18 |
| Green | 016-0725-05 | $18 |
| Blue | 016-0725-06 | $18 |
| Purple | 016-0725-07 | $18 |
| Magenta | 016-0725-08 | $18 |
| 9-Pen Multicolor Pack | 016-0725-09 | $47 |

**4663, 4662 Option 31 Transparency Pens**
Individual Colors Available in 3-Pen Packs

| | | |
|---|---|---|
| Black | 016-0469-00 | $10 |
| Brown | 016-0469-01 | $10 |
| Red | 016-0469-02 | $10 |
| Orange | 016-0469-03 | $10 |
| Yellow | 016-0469-04 | $10 |
| Green | 016-0469-05 | $10 |
| Blue | 016-0469-06 | $10 |
| Purple | 016-0469-07 | $10 |
| Magenta | 016-0469-08 | $10 |
| 9-Pen Multicolor Pack | 016-0469-09 | $25 |

**4663, 4662 Option 31 Wet Ink Pens**

| | | |
|---|---|---|
| 0.3 mm (0.01 in) Dia Tip Pen Body | 016-0444-01 | $23 |
| 0.5 mm (0.02 in) Dia Tip Pen Body | 016-0442-01 | $23 |
| 0.8 mm (0.03 in) Dia Tip Pen Body | 016-0443-01 | $23 |

**Replacement Tips**

| | | |
|---|---|---|
| 0.3 mm (0.01 in) Dia Tip | 214-2706-00 | $20 |
| 0.5 mm (0.02 in) Dia Tip | 214-2706-01 | $20 |
| 0.8 mm (0.03 in) Dia Tip | 214-2706-02 | $20 |

**4662 Paper Pens (Standard 1-Pen Unit)**
Individual Colors Available in 3-Pen Packages

| | | |
|---|---|---|
| Red | 016-0589-00 | $8.00 |
| Green | 016-0589-01 | $8.00 |
| Black | 016-0589-02 | $8.00 |
| Blue | 016-0589-03 | $8.00 |

**4662 Transparency Pens (Standard 1-Pen Unit)**
Individual Colors Available in 3-Pen Packages

| | | |
|---|---|---|
| Black | 016-0648-00 | $8.00 |
| Brown | 016-0648-01 | $8.00 |
| Red | 016-0648-02 | $8.00 |
| Orange | 016-0648-03 | $8.00 |
| Yellow | 016-0648-04 | $8.00 |
| Green | 016-0648-05 | $8.00 |
| Blue | 016-0648-06 | $8.00 |
| Purple | 016-0648-07 | $8.00 |
| Magenta | 016-0648-08 | $8.00 |

**4662 Wet Ink Pens (Standard 1-Pen Unit)**

| | | |
|---|---|---|
| 0.4 mm (0.01 in) Dia Tip w/Pen Body | 016-0448-00 | $24 |
| 0.5 mm (0.02 in) Dia Tip w/Pen Body | 016-0449-00 | $24 |
| 0.6 mm (0.03 in) Dia Tip w/Pen Body | 016-0450-00 | $24 |

**Replacement Tips**

| | | |
|---|---|---|
| 0.4 mm (0.01 in) Dia Tip | 016-0445-00 | $18 |
| 0.5 mm (0.02 in) Dia Tip | 016-0446-00 | $18 |
| 0.6 mm (0.03 in) Dia Tip | 016-0447-00 | $18 |

**Wet Ink Pen Accessories**

| | | |
|---|---|---|
| Replaceable Wet Ink Pens Parts Kit | 006-2968-01 | $11.00 |
| Extra Ink Single Cartridge | 016-0649-00 | $2.00 |

Inks for Polyester Film (¾ oz Squeeze Bottle)

| | | |
|---|---|---|
| Brown | 016-0423-00 | $3.50 |
| Green | 016-0424-00 | $3.50 |
| Blue | 016-0425-00 | $3.50 |
| Red | 016-0426-00 | $3.50 |
| Black | 016-0427-00 | $3.00 |

Inks for Paper (¾ oz Squeeze Bottle)

| | | |
|---|---|---|
| Black | 016-0428-00 | $5.00 |

**Wet Ink Cleaning and Maintenance Systems**

| | | |
|---|---|---|
| Ultrasonic Cleaning Tank | 002-1555-00 | $180 |
| Cleaning Fluid with Strainer 5.2 oz | 002-0920-01 | $6.00 |
| Pressure/Suction Cleaning Bulb | 002-1560-00 | $12 |
| Magnifying Instrument | 002-1558-00 | $120 |
| Pen Storage Humidifier | 002-1559-00 | $14 |

## PLOTTING MEDIA

**4662 Plotter Paper**
Blank White Paper
280 x 432 mm (11 x 17 in) 100 Each

| | | |
|---|---|---|
| B-Size | 006-2410-00 | $13 |

Printed Paper
10 x 10 grid per in (11 x 16.5 in) 100 Each

| | | |
|---|---|---|
| Linear Paper | 006-1698-00 | $12 |

10 x 10 grid per in (11 x 16.5 in) 100 Each

| | | |
|---|---|---|
| Linear Paper | 006-1699-00 | $12 |

10 x 3 Cycle (11 x 16.5 in) 100 Each

| | | |
|---|---|---|
| Semi-log Paper | 006-1700-00 | $18 |

10 x 2 Cycle (11 x 16.5 in) 100 Each

| | | |
|---|---|---|
| Semi-log Paper | 006-1701-00 | $18 |

2 x 3 Cycle (11 x 16.5 in) 100 Each

| | | |
|---|---|---|
| Full-log Paper | 006-1702-00 | $14 |

**4662 A-Size Plotter Film**
Quick Dry Plotter Film

| | | |
|---|---|---|
| 8.5 x 11 in 50 Sheet Package | 006-5939-00 | $30 |

**4663 C-Size Polyester Film**
Antistatic Polyester Film

| | | |
|---|---|---|
| 17 x 22 in 100 Sheets | 006-2835-00 | $120 |

**4663 C-Size Plotting Paper**
Translucent Bond
18 in x 200 ft (2 Each) C-Size After Tear Off

| | | |
|---|---|---|
| Blank Roll Paper | 006-2837-00 | $40 |

Translucent Bond
18 in x 200 ft (2 Each)
Metric Size A2 After Tear Off

| | | |
|---|---|---|
| Blank Roll Paper | 006-3473-00 | $42 |

Translucent Bond
432 x 559 mm (17 x 22 in), 100 Each

| | | |
|---|---|---|
| Blank Sheet | 006-3150-00 | $16 |

Vellum, 100% Rag Content
432 x 559 mm (17 x 22 in) 100 Each

| | | |
|---|---|---|
| Blank Sheet | 006-2836-00 | $45 |

## COPIER PAPER

**4631, 4632 and 4635**
**Tektronix Standard Dry Silver Paper**
216 mm x 152 m (8.5 in x 500 ft)

| | | |
|---|---|---|
| Single Roll | 006-1603-00 | $90 |
| 4 Roll Carton | 006-1603-01 | $320 |

**4633A, 4634 and 4635**
**Tektronix High Performance Dry Silver Paper**
216 mm x 152 m (8.5 in x 500 ft)

| | | |
|---|---|---|
| Single Roll | 006-2432-00 | $230 |
| 4 Roll Carton | 006-2432-01 | $795 |

**4611/4612 Dielectric Hard Copy Paper**
216 mm x 152 m (8.5 in x 500 ft)

| | | |
|---|---|---|
| 2 Roll Package | 006-2838-00 | $42 |

**4611/4612 Tektronix Dry Copy Toner**

| | | |
|---|---|---|
| 4.9 oz Bottle | 006-2990-00 | $27 |

## PRINTER PAPER AND RIBBONS

**4641 Printer Ribbon**

| | | |
|---|---|---|
| Box of 12 | 119-0820-00 | $180 |

**4642 Printer**
Paper-Tab Stock, Fan Fold,
270 mm x 279 mm (10.6 x 11 in)

| | | |
|---|---|---|
| 2500 Sheets/Carton | 002-0262-01 | $65 |
| Paper Roll Box of 12 | 002-1084-01 | $80 |
| Ribbons Package of 4 | 002-1451-01 | $70 |

**4643 Printer Ribbon**

| | | |
|---|---|---|
| Cassette | 118-1314-00 | $25 |

**4644 Printer Ribbon**

| | | |
|---|---|---|
| Box of 6 | 118-3876-00 | $140 |

## MAGNETIC MEDIA

**4110 Series 8 inch Flexible Magnetic disk**
512 kbytes Formatted Capacity

| | | |
|---|---|---|
| Box of 10 | 119-1376-01 | $110 |

**4170, 4925 and 4926 Option 25 Flexible 5¼ inch Disk**
650 kbytes Formatted Capacity

| | | |
|---|---|---|
| Box of 10 | 119-1583-01 | $55 |

**4905 Options 31 & 32 Flexible 8 inch Magnetic Disk**
315 kbytes Formatted Capacity

| | | |
|---|---|---|
| Package of 10 | 119-0848-01 | $115 |

**4907 Flexible 8 inch Magnetic Disk**
630 kbytes Formatted Capacity

| | | |
|---|---|---|
| Package of 10 | 119-1011-01 | $150 |

**4905 Options 33 and 34**
Hard Disk Pack Formatted Capacity

| | | |
|---|---|---|
| 5 Mbyte | 119-0855-00 | $250 |

**4909 Disk Cartridge**
13 Mbyte

| | | |
|---|---|---|
| Formatted Capacity | 119-1462-00 | $360 |

**4050 Series, 4923 and 4924**
Certified Data Cartridge 300 ft

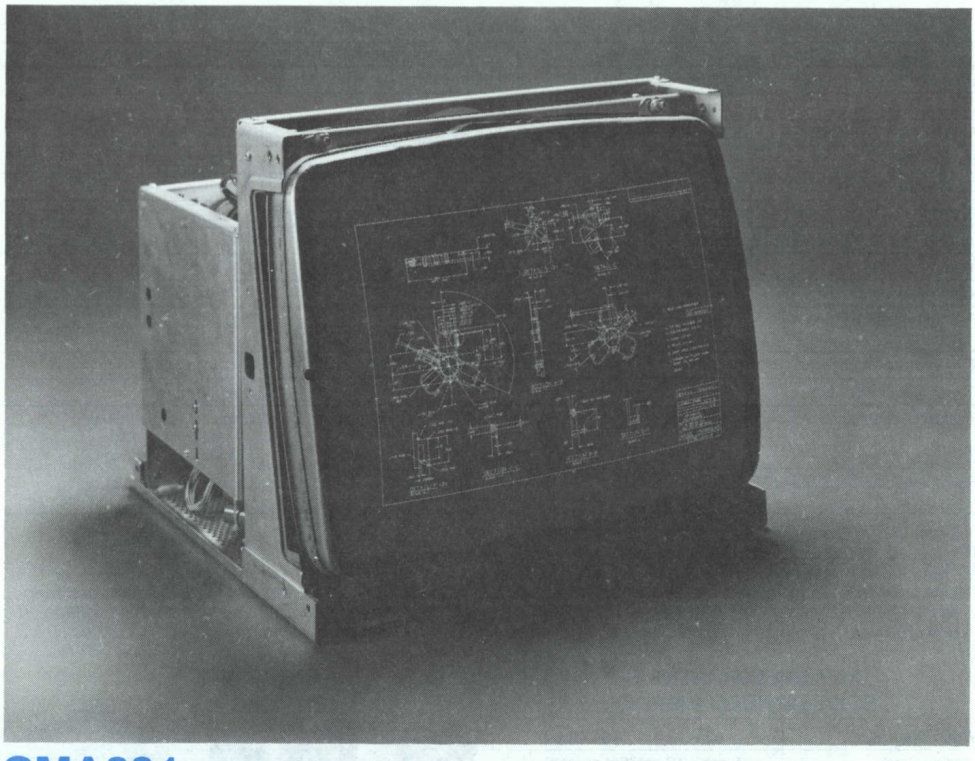
| | | |
|---|---|---|
| Each Cartridge | 119-0680-00 | $30 |
| Package of 5 | 119-0680-01 | $120 |

Certified Data Cartridge 450 ft

| | | |
|---|---|---|
| Cartridge | 119-1439-00 | $35 |
| **Package of 5** | 119-1439-01 | $175 |

Certified Data Cartridge (4050 Series Only)

| | | |
|---|---|---|
| 600 ft Cartridge | 119-1463-00 | $45 |



# GMA201

**Monochrome Raster Display Monitor**

**High-Resolution Video for the System Builder**

**Bright, Stable Noninterlaced 60 Hz Refresh**

**200 MHz Video Amplifier Bandwidth**

**ROM-Based Dynamic Focus**

**Modular Construction for Easy Field Service**

### Unparalleled raster scan video performance

The GMA201 is an OEM product that is well-suited to system builders in the fields of gray-scale imaging, CAD/CAM, computer-aided publishing, document retrieval, and related technical applications that require extremely high performance.

Key features of the GMA201 monochrome display include 1536 vertical by 2048 horizontal addressable pixels, digitally-adjusted focus and astigmatism correction provide a crisp, well-focused beam at all points on the screen over the entire range of gray-scale. A patented low-capacitance gun structure was developed to address the requirements for small uniform spot size, rugged construction and low power dissipation. The flicker-free 60 Hz noninterlaced refresh, high bandwidth 200 MHz amplifier and contrast enhancement panel affords maximum image fidelity. The GMA201 complies with worldwide safety and emissions standards.

We know that your systems can only be as reliable as the components that go into them. For that reason we place a premium on dependability. We produce products that will keep you and your customers satisfied and your service costs down.

Consider the advantages of working with Tektronix—built-in reliability, measureable value, extensive service and support. Your local Tektronix OEM representative will show you how to profit from a partnership with Tektronix.

## CHARACTERISTICS

### DISPLAY

**Addressable Area** — 267 mm x 356 mm (10.5 in x 14 in).

**Addressable Resolution** — 1536 pixels x 2048 pixels at 60 Hz noninterlaced.

**Aspect Ratio** — 3:4 nominal.

**CRT Orientation** — Long axis horizontal.

**Brightness** — 100 cd/m2 (30 fL) with installed contrast enhancement filter.

**Geometric Distortion** — Incremental nonlinearity: ±3% at 25°C. Positional Accuracy: ±1% of image height. Peak-To-Peak Line Variation: ±5%.

**Spot Size** — 7.5 mils (0.19 mm) center screen (maximum). 9.0 mils (0.23 mm) corners (maximum).

**Focus, Astigmatism** — Dynamically controlled, digitally adjusted using ROM look-up table.

**Phosphor Type** — WW (P4).

**Compliance** — UL, FCC, VDE (with Option 23).

### VIDEO AMPLIFIER

**Bandwidth** — Dc to 200 MHz (−3 dB)

**Pulse Response** — $T_r \leq 1.75$ ns. $T_f \leq 1.75$ ns.

### VIDEO INPUT

**Interface** — Linear, dc coupled.

**Impedance** — 50 Ω.

**Recommended Input Signal Rise and Fall Time** — ≤1 ns.

**Level** — Black = 0 V, white = +1.0 V.

**Maximum Nondestructive Input** — +5 V, −2 V.

### SYNC INPUTS

**Interface** — TTL Compatible, falling-edge triggered.

**Horizontal Sync** — 93.6 kHz, ±2%.

**Vertical Sync** — 50 Hz or 60 Hz ± 3 Hz. Factory-calibrated to 60 Hz.

**Vertical Retrace Time** — ≤ 250 μs.

**Horizontal Retrace Time** — ≤2 μs.

### AC POWER

**Range** — 87 V to 128 V, 174 V to 256 V, all at 48 Hz to 63 Hz.

**Power Consumption** — 150 W maximum.

### CONDITION INDICATORS

Scan fail, low-voltage power supply, high-voltage power supply.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 447 | 17.6 |
| Height | 389 | 15.3 |
| Depth | 485 | 19.1 |
| **Weight** | **kg** | **lb** |
| Net | 25.0 | 55.0 |

## ORDERING INFORMATION

**GMA201** Monochrome Raster Display Monitor **$3,675**

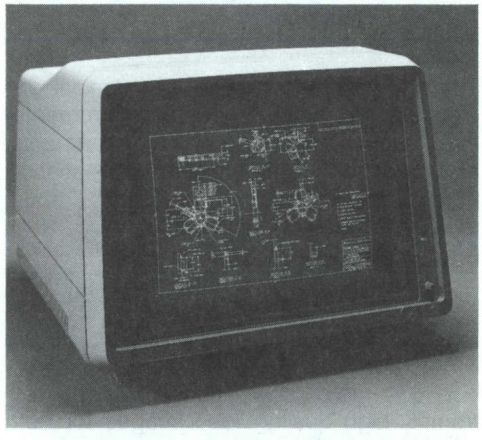
**Includes:** Service manual (010-5079-00).

**Option 23*[1]** — Cabinetry and CRT Bezel. **+$870**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

*[1] *Option 23 includes a standard North American 115 V power plug. Option 23 is required to order A1-A5 power plugs.*



*Option 23*

**Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.**

620 (With Option 23)

## 606B Monitor

**Very High Resolution X-Y Display for Applications Requiring the Most Critically Sharp Photographs and Displays**

The 606B offers image stability, gray-scale performance, and uniform brightness, critical to the quality of measurement or the accuracy of a medical diagnosis.

## 608 Monitor

**High Resolution with Ambient-Light Viewing**

**Expansion-Mesh-Halo Suppression**

**Excellent Gray Scale. High Brightness Display**

The 608 is Tektronix's finest directed-beam viewing monitor. It is extremely well suited for high-performance display applications such as medical and military imaging and electronic instrumentation. The 608's high usable brightness, small spot size, and large screen give excellent direct-viewing capability. It produces detailed displays that are easy to read in high ambient light and produce quality photographs.

## 620 Monitor

**General Purpose, Economical, X-Y Waveform Display**

The 620 is a dependable, economical display, designed for electronic instrumentation, mechanical measurement instruments, and medical A-mode imaging applications.

## 634 Monitor

**High Resolution Video Display for Critical Applications (1400 Lines, Shrinking Raster)**

The 634 raster scan monitor delivers extremely high quality video images for both viewing and photography.

**SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMs. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.**

### KEY SPECIFICATIONS FOR X-Y DISPLAYS

| | 606B | 608 | 620 |
|---|---|---|---|
| Spot Size*1 | 0.08 mm (3.1 mils) | 0.26 mm (10 mils) | <15 mil <25 mil at max drive |
| Display Size | 8 cm x 10 cm | 9.8 cm x 12.2 cm | 10 cm x 12 cm |
| Acceleration Potential | 5.5 kV | 22.5 kV | 12.0 kV |
| Bandwidth, X-Y*2 | >3 MHz | ⩾5 MHz | ⩾2 MHz |
| Bandwidth, Z*2 | 5 MHz | ⩾10 MHz | ⩾5 MHz |
| Risetime | <35 ns | ⩽35 ns | |
| Input R and C, X-Y*3 | 1 MΩ ±1% or 50 Ω‖<47 pF | 1 MΩ‖⩽60 pF | 1 MΩ <47 pF |
| Input R and C, Z*3 | 1 MΩ or 5 MΩ | 1 MΩ ⩽60 pF | 1 MΩ <47 pF |
| X-Y Phase Difference | 1° to ⩾500 kHz | ⩽1° to 1.5 MHz | ⩽1° dc to 500 kHz |
| Recommended Source Impedance, X-Y and Z | <10 Ω in 1 Ω pos. | ⩽10 kΩ | ⩽10 kΩ |
| Temperature Range | 0°C to 50°C | 0°C to +50°C | 0°C to +50°C |
| Power Requirements*4 | 75 W | 61 W | See footnote*4 |
| Included Accessories | | Lined external implosion shield (graticule) for adjustment purposes. | Lined external implosion shield (graticule) for adjustment purposes. |
| Recommended Cameras | C-30BP, C-5C Opt. 01 C-7 Opt. 01 | C-5C Opt. 01, C-7 Opt. 01 C-59A | C-5C, C-5C Opt. 01 C-7 Opt. 01 |

*1 *Measured at 0.5 μA, except for the 606A, measured at 0.1 μA.*
*2 *Full spec would read: "dc to . . ." appropriate figure.*
*3 *"‖<" means "paralleled by less than".*
*4 *Line voltage selector allows operation from 100 V, 110 V, 120 V, 200 V, 220 V, and 240 V (± 10% on each range). 48 Hz to 440 Hz (except the 624 which excludes 220 V). Number given shows watt max at nominal line voltage. The 620's power requirements are 90 V ac-132 V ac; 48 Hz-440 Hz line frequency, 22 W max, 0.2A at 120 V ac 60 Hz.*

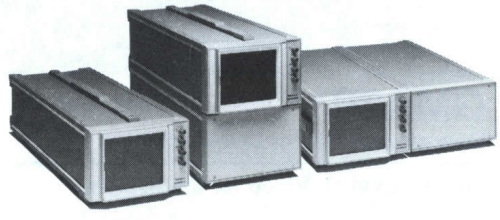
### KEY SPECIFICATIONS FOR 634 VIDEO DISPLAY

| Video Display | | 634 | 634 Opt. 01 |
|---|---|---|---|
| Display Size | | 9 cm x 12 cm (flat screen) | |
| Resolution*1 | Worst Case | 1100 line | 650 line |
| | Nominal | 1400 line | 800 line |
| Position Accuracy/ Nonlinearity | | ⩽0.5% within 9 cm circle. ⩽1% in corners. For Option 01: 1% within 9 cm circle, 2% at corners | |
| Brightness | | 515 cd/m² (150 fL) max. | |
| Brightness Nonuniformity | | Less than ±10% | |
| Bandwidth | | 1 Hz-10 Hz std. 20 MHz Video bandwidth available as Option 14. | |

*1 *Merged raster lines.*

*Note: Standard 634 accepts the line/field rate of 625/50. Discrete line rates of 675/60 through 1083/60 can be accommodated using option 15.*

**Recommended Cameras:** C-5C Opt. 01, C-7 Opt. 01, C-59A.



### ORDERING INFORMATION

**606B** Monitor (without handle, feet or covers) **$4780**

**608** Monitor (without handle, feet or covers) **$2935**

**620** Monitor (without handle, feet or covers) **$1720**

**634** Monitor (without handle, feet or covers) **$3500**

| | 606B | 608 | 620 | 634 | Description | Price |
|---|---|---|---|---|---|---|
| Option 01 | | ✓ | ✓ | | Internal Graticule | NC |
| Option 01 | | | | ✓ | Resolution of 800 Line Nominal, 650 Worst Case | −$150 |
| Option 06 | | | ✓ | | UL 544 (Includes Handles, Feet and Covers) | +$100 |
| Option 06 | | | | ✓ | | +$105 |
| Option 06 | ✓ | | | | | +$125 |
| Option 07 | ✓ | | | | Screwdriver Front Panel Controls | +$30 |
| Option 09 | ✓ | ✓ | | | UL 544 Component Recognized | NC |
| Option 10 | | ✓ | ✓ | | 25-Pin Remote Program Connector | +$55 |
| Option 13 | | | | ✓ | Reverse Video | +$85 |
| Option 14 | | | | ✓ | 20 MHz Video Amplifier | +$145 |
| Option 15 | | | | ✓ | Variable Line Rates | +$280 |
| Option 16 | | | | ✓ | 25-Pin Video Input | +$55 |
| Option 20 | | | ✓ (6, 31)*1 | ✓ | Ac Delete | −$20 |
| Option 21 | | ✓ | | | Full Differential Inputs | +$60 |
| Option 22 | | ✓ | | | Extended Gain Range | +$45 |
| Option 23 | | ✓ (28)*1 | ✓(6, 28, 31)*1 | | Handle, Feet and Covers | +$110 |
| Option 24 | | ✓ | | | Linearized Z-axis | +$75 |
| Option 25 | | ✓ | | | TTL Blanking | +$75 |
| Option 28 | ✓ (6)*1 | ✓ (23)*1 | ✓(6, 23, 31)*1 | | Covers Only | +$90 |
| Option 29 | | ✓ | | | Metal Bezel | +$70 |
| Option 31 | | | ✓ | | Delete all Rear BNC's, Dc Power Connector and Ac Power Supply and Switch | −$25 |

*1 *Not available with these options.*

*ADS05 Workstation Cart for the Tek 4100A Series computer display terminals.*

*AnthroCart shown with slide out shelf option.*

## ADS05

The ADS05 mobile workstation provides optimum control and organization of your workspace. Its rugged construction and roll-around feature make it ideal for scientific-engineering environments. Designed for Tek's 4100A Series computer display terminals and peripherals, the ADS05's shelves can be configured so your equipment is organized in the most efficient way for your application.

The ADS05 combines durability with functionality. Work surfaces are non-glare, high pressure laminate on 1-inch particle board with rounded vinyl T-molded corners for safety. All wire components (document holder, basket, base grid) are heavy gauge steel with baked on finish. Castors are quiet, soft rubber, two of which are locking. All tubing is 16 gauge, seam welded, cold rolled steel with a durable baked finish to resist scuffs and scratches.

The ADS05 comes standard with one large shelf, two small shelves, two wire storage baskets, basket mounts and locks, wire base grid, document holder, cord management clips and assembly tools. The ADS05 has a slate gray work surface.

## Anthro Features

- **Mobile**
- **Stacks Vertically in a 5 1/2 Square Foot Area**
- **16 Gauge Rugged Steel Base**
- **Supports up to 68 kg (150 lb) of Equipment**
- **Shelves Adjustable in 25 mm (1 in) Steps**
- **Swing Out Baskets Included for Storage**
- **Five Year Warranty**

### PHYSICAL CHARACTERISTICS

| | ADS05 | | AnthroCart | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 635 | 25.0 | 635 | 25.0 |
| Height | 1092 | 43.0 | 889 | 35.0 |
| Depth | | | | |
| Keyboard Shelf | 914 | 36.0 | 762 | 30.0 |
| Basket | 102 | 4.0 | 102 | 4.0 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Shipping*[1] | 45.4 | 100.0 | 33.8 | 68.0 |

*[1] *Product shipped flat, easily assembled using supplied tools.*

### ORDERING INFORMATION

**ADS05** **$595**

**Order from your local Tektronix sales office.**

**AnthroCart** **$495**

**Order from Anthro Corporation, 3221 NW Yeon Street, Portland, OR 97210, (503) 241-7113**

**See optional accessories on next page.**

## AnthroCart™

The AnthroCart gives Tekstation and PC users a solution to their technology furniture needs. As PCs impact the engineering workspace, space and mobility issues become increasingly important.

Because quality construction is combined with a flexible design, the AnthroCart will house virtually any desktop PC model. The shelves can be adjusted up and down to accommodate most hardware and can be positioned for a stand-up or sit-down application.

The AnthroCart is six inches less deep than the ADS05 cart, to maximize space savings. With the Anthro options listed on the next page, you can customize your cart exactly to your needs, and still maintain a small 5 1/2 square foot footprint.

The AnthroCart's material make-up is addressed in the ADS05 description. Tested up to 600 pounds, the AnthroCart will hold up to 150 pounds of equipment.

The AnthroCart comes standard with one large shelf, one small shelf, one wire storage basket, basket mounts and lock, wire base grid, document holder, cord management clips, and assembly tools. The work surface is available in oak or slate gray color.

## AnthroCart Optional Accessories

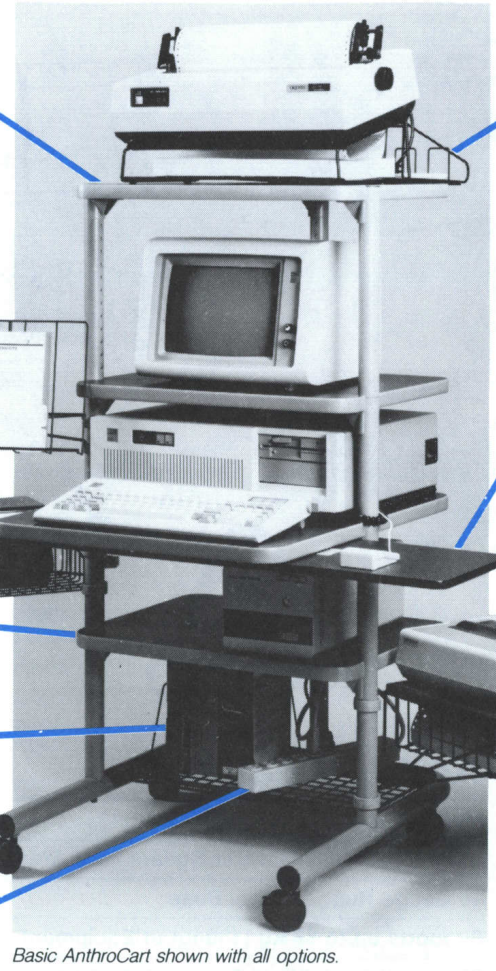
1. **Extension Shelf Kit**
Extension Shelf (18.7 x 23.75 inches) gives extra space for large printers, additional monitors, and other equipment. Same high pressure laminate surface as the basic AnthroCart shelves. Maximum height of the AnthroCart with extension shelf is 48 inches. Specify light oak or slate gray finish.
Order 121-010-00 **$119.95**

2. **Additional Basket**
Four-inch deep swing out baskets accommodate storage, documentation and more. Plastic lock (included) secures basket in position. Specify right or left basket.
Order 310-000-00 **$49.95**

3. **Additional Shelf**
Can be used for hard disk, power supply, documentation, supplies and more. Measures 18.7 x 23.75 inches. Specify light oak or slate gray finish.
Order 121-000-00 **$59.95**

4. **Book Ends**
Perfect for organizing books, software manuals and more. Designed to fit into base grid. Set of two.
Order 370-000-00 **$24.95**

5. **Surge Protector**
Series 9 conditioned six-outlet power strip with heavy duty transient voltage surge suppressor.
Order 520-006-00 **$116.95**



*Basic AnthroCart shown with all options.*

6. **Paper Feed and Catch**
Handles your printer paper flow. Sturdy steel frame holds both 132- and 80-column printers. Holds up to 5 inches of paper. Sits easily and safely atop extension shelf kit.
Order 380-000-00 **$79.95**

7. **Slide Out Shelf**
Attaches under the keyboard shelf and slides out to right of the keyboard shelf or to the left. Measures 11½ x 11¼ inches. Can be used for a mouse, digitizer pad or extra documentation. Available in slate gray color only.
Order 140-000-00 **$89.95**

8. **Printer Basket**
Designed to hold 80-column printers. Basket measures 18½ inches (depth) x 18½ inches (width). Holds up to 20 pounds. Open side allows paper to feed into printer. Accommodates up to 3½ inches of paper, swings out for accessibility, plus includes lock to secure basket in closed position.
Order 340-000-00 **$119.95**

### ORDERING INFORMATION

**Order these and other options through Anthro Corporation, 3221 NW Yeon Street, Portland, OR 97210, (503) 241-7113.**

## AnthroArm®

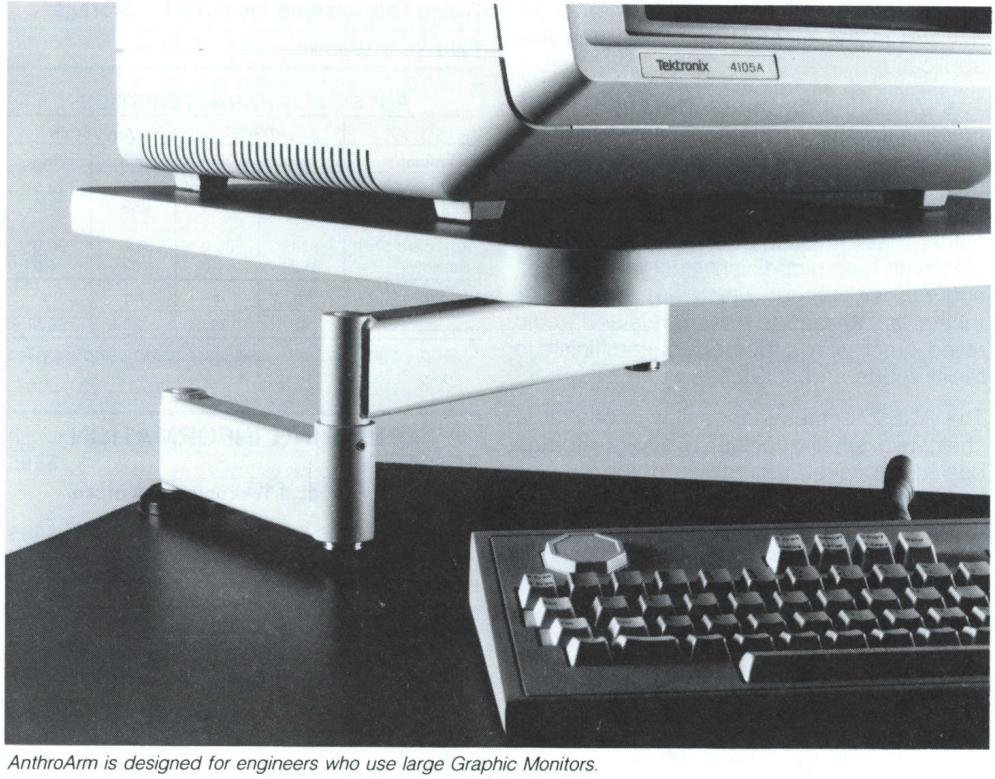
The AnthroArm is designed to elevate a monitor above a desk to provide maximum work space. The AnthroArm makes it easy to store and move equipment. The arms and monitor shelf swivel 360° for accessibility and convenience. With the AnthroArm, you are able to swing the monitor out of the way when not in use, so you can make the most of your available work area. Made of solid aluminum construction, AnthroArm has a load capacity up to 200 pounds (90 kg). Ideal for heavy 19" graphic monitors.

### ORDERING INFORMATION

**AnthroArm** **$599**

**For information pertaining to your application needs and installation specifications, call or write Anthro Corporation.**

*ANTHRO is a registered trademark of ANTHRO Corporation, a wholly owned subsidiary of Tektronix, Inc.*




*AnthroArm is designed for engineers who use large Graphic Monitors.*

# DESIGN AUTOMATION PRODUCTS

## CONTENTS

Software Development Products ..... 86
Logic Analyzers ..... 101
Semiconductor Test Systems ..... 132

Tektronix Design Automation products provide a comprehensive array of tools intended for engineering, production, and service applications throughout the electronics industry. As the electronics industry demands ever-increasing front-end design automation via computer-aided processes, Tektronix' Design Automation tools respond with computer-aided software engineering systems and with test and measurement linkages to CAE and CASE Systems. In applications ranging from VLSI prototype verification and computer servicing, to microcomputer software development, to production semiconductor testing, products from the Design Automation Group have set the industry standard for versatility, innovativeness, and performance.

**Software Development Products**
The Software Development Products (SDP) Division provides its customers with a wide variety of quality software development "error prevention" tools and software/hardware integration products. These CASE (Computer-Aided Software Engineering) products and services which are used throughout the software development lifecycle "from concept to code". SDP's products and services facilitate software design, implementation, documentation, simulation, and debug in a known good environment—as well as the integration of software in a prototype hardware environment.

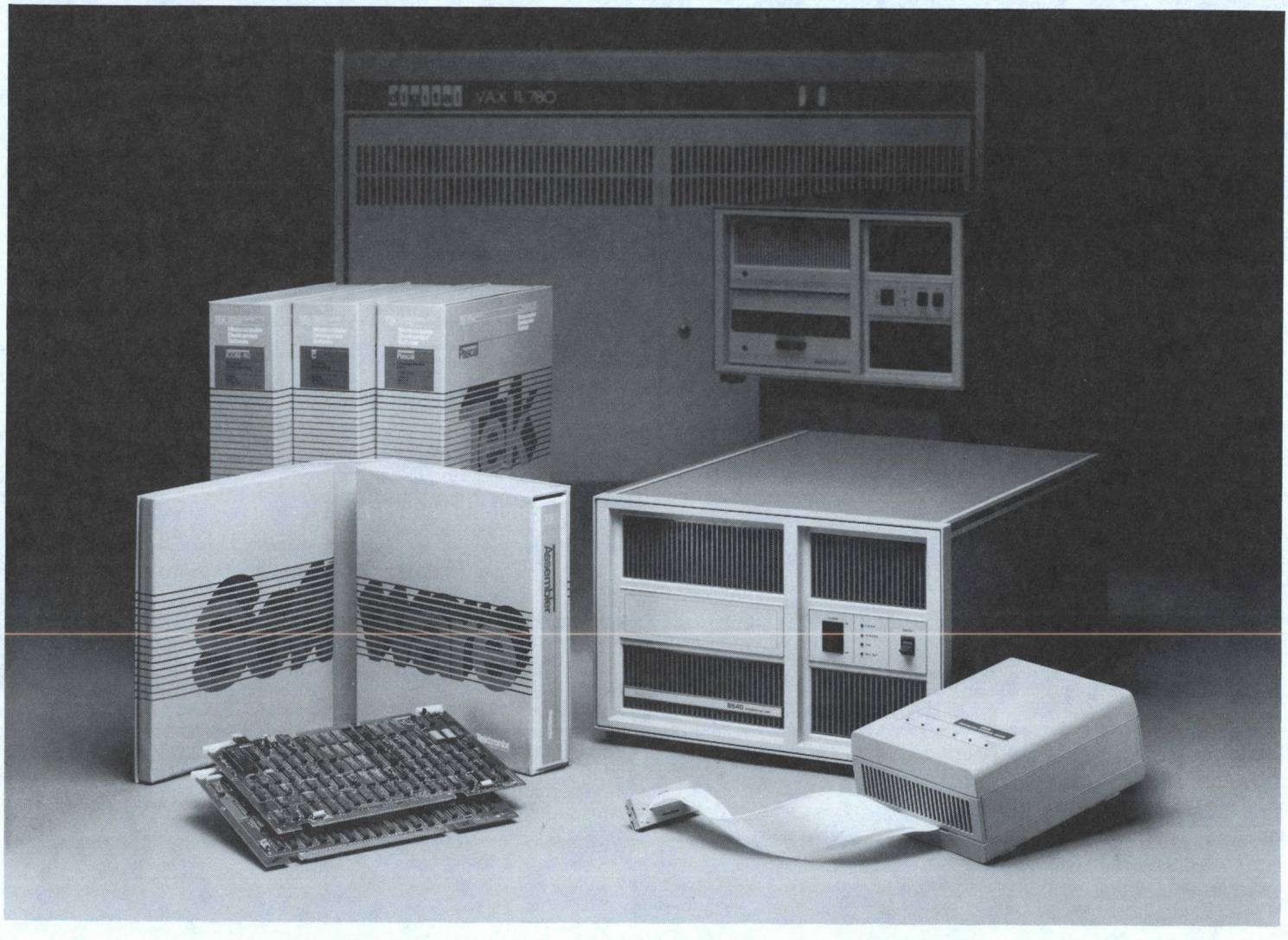
**Logic Analyzers**
The Logic Analyzer Division provides instrumentation for testing and measuring digital hardware and software throughout the entire cycle of design, manufacture, and service. This instrumentation includes data acquisition, pattern generation and data analysis capabilities.

The breadth and modularity of the Logic Analyzer product line insures powerful, cost-effective solutions for applications ranging from testing VLSI devices to troubleshooting failing equipment remotely over telephone lines.

**Semiconductor Test Systems**
The Semiconductor Test Systems (STS) Division furnishes integrated circuit manufacturers and users with computer-controlled automated IC test sytems ranging from compact production testers to full scale characterization machines.

Every STS system includes a complete package of the functional, AC parametric, and DC parametric test features required for thorough integrated circuit testing at any level. STS systems are often called upon to do device characterization during the first shift, to run high-volume production tests through the second shift, and to analyze results and generate reports during the third. STS products are designed to serve customers who demand precision and accuracy combined with cost-effectiveness.

# SOFTWARE DEVELOPMENT PRODUCTS






## SDP Now Supports

*MOTOROLA*
*68000*
*68008*
*68010*
*6809*
*6809E*
*6801*

*INTEL*
*8086/87*
*8088/87*
*80186*
*80188*
*8085A*
*8051*
*8048*
*8021*
*8041A*
*8022*

*ZILOG*
*Z80*
*Z80CMOS*
*Z8001/2*

*OTHER*
*1750A*
*F9450*
*9900/9989*
*NSC800*
*70108/V20*
*70116/V30*
*7809/08/07*
*7810/11/16*
*78C05/06*

## SDP Future Support

*68020*
*80286*
*68HC11*

*and more to come. . .*

# CONTENTS


Introduction ..... 86
Product Development Cycle ..... 88
Product Definition ..... 89
- Structured Analysis
- Structured Design

Language Development Systems ..... 91
- LANDS
- Language-Directed Editors
- Compilers
- Integration Control System
- High-Level Debug
- Assemblers and Linkers

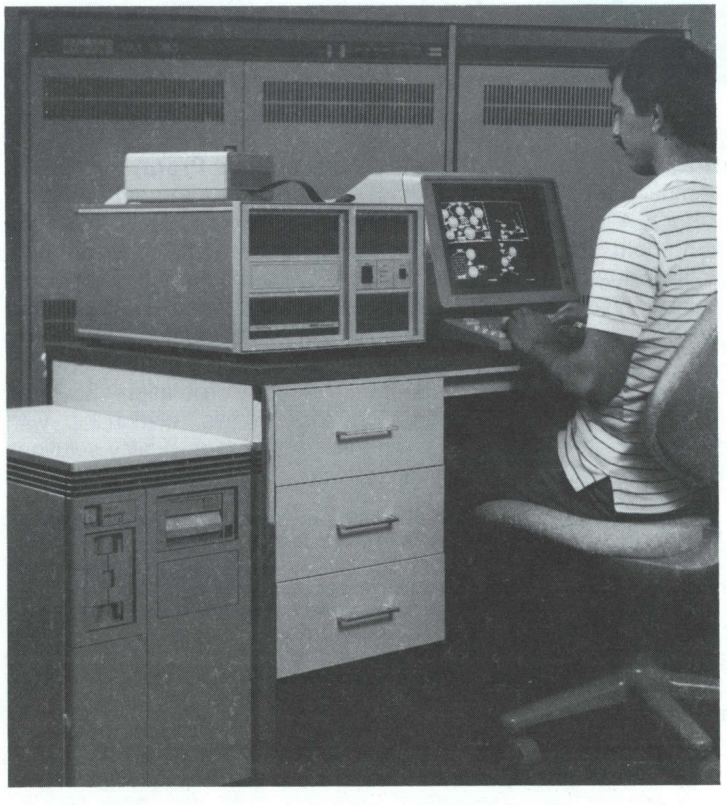
Design Environment ..... 92
- Host Environments
- 856X Series
- Tek/DEC Software
- ColorKey+ User Interface
- IBM PC Software
- ICOM40A Communications

Microprocessor Support Systems ..... 94
- TekMate
- 8540A
- Real Time Emulation
- Trigger Trace Analyzer
- Three Modes of Emulation

16-Bit Microprocessor Support ..... 96
- Real Time Operating System
- Digital Design Lab
- Support Chart

Aerospace/Defense Applications ..... 97
Services ..... 98
- Applications Engineering Services
- Software Subscription Service
- Customer Training

Ordering Information ..... 99

Tektronix SDP (Software Development Products Division) offers a broad range of quality software development and software/hardware integration products. SDP was formerly MDP (Microcomputer Developments Products Division). The name was changed to better reflect the type of products now being offered by this division to meet the needs of a rapidly changing market.

**SDP Mission Statement**
SDP provides CASE (Computer-Aided Software Engineering) products and services to be used throughout the software development life-cycle. These products and services facilitate software design, implementation, documentation, simulation, and debug in a known good environment as well as the integration of software in a prototype hardware environment.

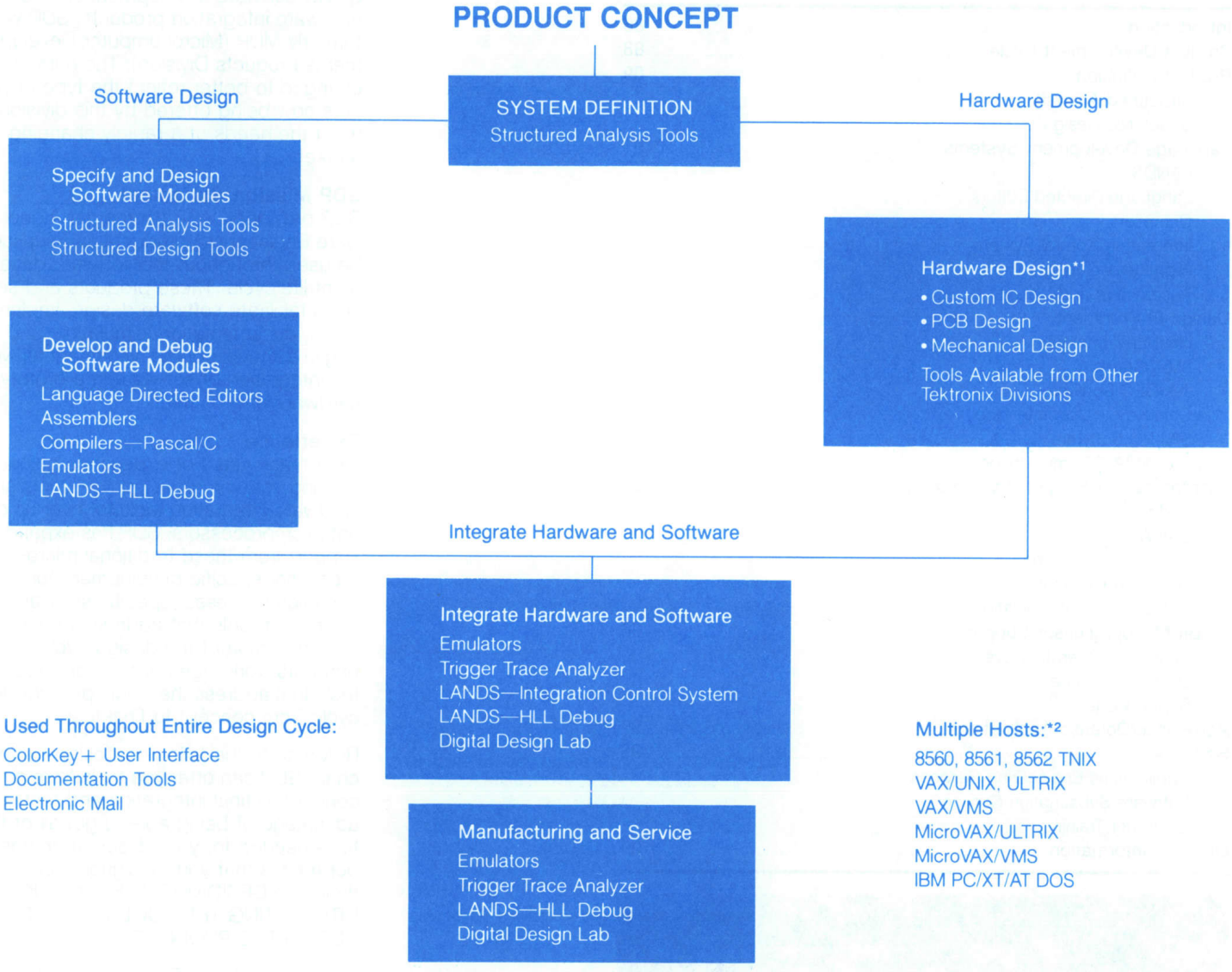
**Experience**
After many years of experience gained by offering software development tools and hardware integration tools for over 35 different microprocessors, SDP has expanded its support from these traditional microprocessor specific development tools to non-microprocessor specific software development tools that address the system design portion of the design cycle. These products work together to offer a system of tools that address the whole product design cycle from concept to final test.

Referring to the following design cycle chart, SDP can offer you tools from product concept to final integration and test. The advantage of being able to get all of the tools needed for your design from one vendor means that your designers can spend their time DESIGNING THE PRODUCT, NOT INTEGRATING THE TOOLS NEEDED TO DESIGN THE PRODUCT.

Tektronix Software Development Products Division offers the broadest range of quality multiple microprocessor support available today. Tektronix won't lock you into one microprocessor family or vendor. Plus, every Tektronix SDP System is backed with nearly 40 years experience in meeting designer's needs. We test our Development Products thoroughly to ensure performance and reliability. Each one provides complete development capability and the Tektronix commitment that guarantees you'll keep abreast of the fast paced microprocessor technology.

Call your local specialist today to find out more about Tektronix SDP Systems.

# PRODUCT DEVELOPMENT CYCLE






## Tek Tools for the Whole Design Cycle

### New Front End Tools for Error Prevention

SDP continues to expand support to meet the needs of today's market. Structured Design tools have been added to complement the Structured Analysis set of tools to take you from system specifications to system design. These two tools greatly enhance the productivity of both the software engineer and the hardware engineer.

### New Low-Cost Tools

Another exciting *NEW* product is TekMate, a new system of high performance low cost 8-bit emulation tools that pack all of the experience of Tektronix emulators into a small monolithic package that can connect to a variety of host computers. TekMate meets all of your needs for Z80, 8085, and 6809 development work. Available soon will be support for the 68HC11 microcomputer.

### Support for Current Products

For those who need to eventually add 16-bit development capability, the 8540A is the system of choice. Supporting both 8-bit and 16-bit emulators, the modular 8540A can be easily configured for the support you need.

*NEW* this year is support for the NEC 7800 Family, NEC V20/V30, and the F9450 microprocessors.

In addition to new hardware support, the Language Development System (LANDS) product line has been expanded to offer support for the C language in addition to Pascal for the Motorola 68000/08/10 and the Intel 8086/88/186/188 Families.

### Advanced Microprocessor Support

Also available in the near future is support for popular 32-bit microprocessors, such as the Motorola 68020. Contact your local SDP sales representative for more information.

### Software Connections Program

SDP has developed a program with key quality vendors to offer products that complement SDP's product line. The program includes IBM PC based language products from Microtec Research, real-time operating systems (VTRX) from Hunter-Ready, and specialized software execution environments from Mikros Corporation. SDP will continue to expand this relationship with other vendors to offer high quality solutions for your software development needs.

**1 Tek also offers a wide range of CAE tools for your hardware design task.*

**2 VAX, VMS, ULTRIX, and MicroVAX are trademarks of Digital Equipment Corporation.*
*UNIX is a trademark of AT&T Bell Laboratories.*
*IBM PC/XT/AT are trademarks of International Business Machines Corporation.*
*TNIX is a trademark of Tektronix, Inc.*

# Structured Analysis Tools

**Specify System Conceptual Requirements Graphically**

**Evaluate Specifications Automatically for Accuracy and Completeness**

**Improve Product Quality**

**Reduce Development Time and Costs**

To address the System Definition portion of the product development cycle, Tektronix offers SA Tools. SA Tools is a set of "Error Prevention" front end design tools used to avoid errors before your design begins. These graphically oriented software development tools automate the Structured Analysis (SA) method of system modeling. SA Tools ensure that a system specification is complete, consistent, and well structured.

Tektronix SA Tools support the SA method described in *Structured Analysis and System Specification*, by Tom De Marco. SA is a systematic, graphic, top-down way to describe what a system does.

SA's graphic notation encourages team analysis and a thorough understanding of requirements. Using SA, designers develop a solid specification before design begins.

An SA specification is tedious to maintain manually. SA Tools automate the functions a computer can do best: drawing diagrams, organizing documents, checking details, preserving consistency, and making copies.

While SA Tools handle the routine details, the designer is free to concentrate on system analysis. Creating, evaluating, modifying, and copying a specification can be done quickly online. SA Tools allow designers to improve product quality, reduce development time and costs, and manage projects effectively.

## SA TOOLS FUNCTIONS

SA Tools support the SA methodology by automating the routine tasks of specifying a system. They let designers create, analyze, modify, and display a graphical specification of the system to be developed.

### Editing

A special-purpose interactive graphics editor lets designers create and modify DFDs (Data Flow Diagrams) online. With the editor, designers can create, label, move, change and delete each type of symbol in a DFD.

The graphics editor lets designers move through the SA specification creating child DFDs and MSs (Mini-Specifications). New DFDs are created with parent data flows automatically included (VMS feature). By taking advantage of their terminal's graphics capabilities, designers can also tailor the appearance of DFDs.

The DD and MSs are edited with any text editor, so designers can use the editors they prefer.

### Evaluation

The evaluation tool verifies consistency, completeness, and structure in the SA specification. It identifies inconsistencies between documents and evaluates a documents for adherence to SA guidelines. For example, the evaluation tool checks the consistency of data flows, the complexity of DFDs, and the completeness of the DD.

### Correction

The correction tool helps preserve consistency in the SA specification. For example, this tool maintains consistency of process names, and consistency between data flows and the DD.

### Display

The display tool allows designers to show SA documents online or to produce DFD hard copies on Tektronix copiers. Copies can be full or half size, and in color or black and white.

### Auxiliary Tools

Auxiliary Tools support system analysis by performing tasks such as sorting the DD, or listing the processes and data used in the SA documents.

### Combined Tool Use

SA Tools can be combined with one another and with standard operating system commands to perform more complex tasks. For example, the SA commands to list data flows and to look at DDs can be used to show the DD definitions for all data flows in a DFD.

### ColorKey+ User Interface

The Tektronix ColorKey+ user interface makes SA Tools easy to learn and use. Designers can use SA features by pressing function keys or by entering a command directly. With ColorKey+ designers can select an SA document and perform a variety of tasks on that document. Refer to page 93 for more information on ColorKey+.

SA TOOLS FUNCTIONS

| Tool | Function*[1] |
|---|---|
| **Main** | |
| Edit | Edits an SA document |
| Evaluate | Evaluates an SA document |
| Fix | Corrects an SA document |
| Show | Shows an SA document |
| **Auxiliary** | |
| Add TBDs | Adds new entries to the DD |
| DFD plotter | Converts a DFD to the UNIX plot format |
| List data flows | Lists data flow names from SA documents |
| List processes | Lists process numbers and names from SA documents |
| Look | Looks up an entry in the DD |
| Monochrome | Produces a monochrome copy of a DFD |
| Parse | Validates DD Syntax |
| Sort DD | Sorts DD entries alphabetically |

*[1] *Functions and features may differ slightly on different hosts.*

### Host Support

SA Tools run on VAX computers under the VMS, UNIX, and ULTRIX operating systems. The tools also run under TNIX™ on the Tektronix 856X Series Multi-User Software Development System requires floating-point option.

### Configuration Requirements

SA Tools require a Tektronix graphics terminal; a color 410X Series computer display terminal. The 4107A, is recommended because it lets designers have several diagrams on the screen at the same time. Tektronix copiers, such as the 4692 Color Graphics Copier, can be connected to 410X terminals to copy screen contents.

A text editor is required to create and modify the DD and MSs. Tektronix offers various language-directed editors for the VAX and the 856X Series.

SOFTWARE DEVELOPMENT

# Structured Design Tools

**Design Software Graphically**

**Evaluate the Design Automatically**

**Make Hard Copies of Structure Charts**

After using SA Tools to develop a complete and consistent system specification, Tektronix expands its "Error Prevention" front end design tools with Structured Design Tools. Structured Design Tools are used in the design portion of the product development cycle. SD Tools is a set of graphically oriented software development tools that automate structured, graphical methods of software design.

The design phase of a project follows the analysis phase. A system specification such as that produced with Tektronix SA (Structured Analysis) Tools is developed in the analysis phase. Then SD Tools let the designer develop a software design that will achieve the specified functions.

Tektronix SD Tools support the Structured Design method as described in *Practical Guide to Structured Systems Design* by Meilir Page-Jones. Given the specification of system, Structured Design is a systematic, graphic, top-down method of describing the design for a software system. Using SD, designers can develop a complete, viable design before implementation starts.

The benefits of using SD come from the ability to create a well-organized representation of the software before starting to program. SD's graphic notation encourages designers to find the structure for the software system which will best meet its specification.

When maintained manually, the detailed aspects of a Structured Design are tedious and error-prone. SD solves this problem. SD Tools automate the tasks that a computer can do best—drawing and changing diagrams, evaluating the design structure, and displaying the design documents on screen and hard copy.

SD Tools allow designers to improve product quality, reduce development time and costs, and manage their project effectively.

### SD TOOLS FUNCTIONS

SD Tools support the design phase by automating the routine tasks of software design which involve the creation, analysis, modification, and display of Structure Charts (SC).

### Editing

A special-purpose interactive graphics editor lets designers create and modify SCs. With this editing tool, designers can create, label, move, change and delete each item in an SC.

The graphics editor has commands that let designers move through the Structure Charts. Designers can also tailor the appearance of SCs by automatically utilizing their terminal's graphics capabilities.

### Evaluation

The evaluation tool checks for errors and inconsistencies among SCs. It also gives warnings for deviations from the guidelines of the SD methodology. In addition, the user may obtain measures of the system complexity at various levels within the SC hierarchy.

### Display

The display tool can show SC on-line or produce a hard copy. Designers can produce SC hard copies quickly on Tektronix copiers.

### Auxiliary Functions

To help designers improve the specification, SD Tools includes *auxiliary commands*. These commands perform tasks such as listing the module calling tree, and answering user queries about data item references, and parameter usage.

### ColorKey+ User Interface

The Tektronix ColorKey+ interface makes SD Tools easy to learn and use. Designers can access the various features by pressing function keys or by entering a command directly.

Designers can select an SD document and then perform a variety of tasks on that document without repeatedly identifying the document. Refer to page 93 for more information on ColorKey+.

SD TOOLS FUNCTIONS

| Tool | Function |
|---|---|
| **Main** | |
| Edit | Edits an SC |
| Evaluate | Evaluates an SC<br>Reports on complexity of an SC |
| Show | Displays an SC |
| **Auxiliary** | |
| List | Provides descriptions of SC characteristics |

### Host Support

SD Tools run on VAX computers under the VMS, UNIX, and ULTRIX operating systems. The edit and show tools also run under TNIX on the Tektronix 856X Series multi-user software development system with the floating point option.

### Configuration Requirements

SD Tools require a Tektronix graphics terminal; a color 410X Series computer display terminal (the 4107A, is recommended). Tektronix color graphic copiers, such as the 4692 Color Graphics Copier, can be connected to a 410X terminal to copy screen contents.

**Contact your local SDP sales representative for more information.**

# Language Development Systems (LANDS)

**Complete C/Pascal Code Generation Systems**

**Integrated Set of S/W Development Tools**

**Tightly Linked with Emulation Systems**

After using SA Tools to develop your system specifications and SD Tools to design your software modules, you're now ready to develop and debug your code. Tektronix Language Development Systems (LANDS) offers you a comprehensive set of tools for the development, debug, and integration of your software modules.

## LANDS

Using a high-level language to generate code for microprocessors has advantages over assembly language programming since programs are easier to understand and maintain and programmer productivity is higher. To support this, Tektronix SDP offers a language-oriented development system for Pascal or C called LANDS. The LANDS package is an integrated set of language development tools consisting of a language-directed editor, a compiler (Pascal or C) with an Integration Control System (ICS), and a high-level language symbolic debug. These products allow the user to work through the software development and debug cycle in the same high level language from code entry through debugging. An assembler with a linker is also included with the LANDS package.

## LANGUAGE DIRECTED EDITORS

The LDE (Language Directed Editor) included in the LANDS package is an editor that understands Pascal or C syntax. LDE flags any syntax errors in the source code you've entered while you are still in the editor. LDE issues an error message and moves the cursor to the error so that the error can be corrected immediately. The detecting of syntax errors while in the editor eliminates lengthy compilations to locate these errors. LDE is also an excellent general purpose screen-oriented editor.

An auto-indent feature in LDE simplifies the indenting task by remembering the previous indentation level. A GENERIC key reduces the need to type frequently used keywords. LDE provides quick location of language-specific tokens and character strings for editing. LDE is compatible with several terminals.

## COMPILERS—Pascal and C

For high-level language programming, the LANDS Pascal and C cross compilers, provide the benefits of structured languages plus the ability to use microprocessor specific functions. The LANDS Pascal compiler contains many enhancements for microprocessor programming. These enhancements include interrupt handling, bit-level data manipulation, assignment of variables to specific hardware addresses, and direct access to I/O ports without having to resort to assembly language code. In addition, the Pascal compiler provides a separate optimizer pass that can significantly reduce code volumes and boost performance. The LANDS C compiler supports Kernighan and Ritchie's standard C and includes an implementation of the standard I/O libraries.

## INTEGRATION CONTROL SYSTEM

One major task associated with microcomputer design is to correctly interface the software with the specifics of the prototype hardware. When the software has been generated in a high-level language like Pascal or C, this task can become quite complex and time consuming.

LANDS compilers include a unique tool for implementing the hardware/software interface, called the ICS (Integration Control System). The user fills in a brief source file with parameters defining the software modules and hardware configuration. From this source file, ICS automatically handles the details and generates the necessary code and command files to execute code in the target system.

ICS creates a linker command file that adheres to the specified memory parameters. Constants, instructions, and global variables are all automatically assigned to their correct locations within the prototype address space.

ICS generates any code needed to link low-level interrupt vectors to service routines. ICS also generates the object code needed to handle the initialization and reset operations. Normally interrupt, initialization and reset code would have to be manually programmed in assembly language and then linked with the high-level code.

In addition to automating the hardware/software interface task, ICS also creates an emulator command file. This file allows you to download the linked object module and execute it in a single command. You save both time and effort in the debug stage of the design cycle.

## HIGH-LEVEL DEBUG—PASCAL AND C

With most microcomputer software designs, when the program executes on the processor, trace information accumulated by the debug software is displayed in an assembly code format. Unfortunately, when programming in high-level language this debug code bears little or no resemblance to the original Pascal or C source code. A great deal of time and effort is spent figuring out the relationship betweeen assembly-level debug information and the original source code.

Tek's LANDS package solves this long-standing problem with our high level debug. While the program executes on the emulator, the high-level-language debug translates information back into its counterparts at the Pascal or C source code level. All debug operations can be performed at source code level. This completely eliminates the time-consuming requirements of translating assembly-level debug information into its high level counterpart.

With the high-level debug, all your debug commands can be entered using source code terminology. Breakpoints can be set on statement numbers, procedure and function names, or on variables to halt program execution. Values can be returned to calling functions.

The high-level debug also gives you the capability of displaying your program in high-level source form, which speeds up the analysis. For instance, the user can trace function calls and obtain a listing of each time the procedure is entered or exited and the value of any parameters. Also, variables can be displayed, modified and evaluated in their original source code terms. There is no need for the time-consuming task of translating hexadecimal responses to the corresponding high-level language constructs.

## ASSEMBLERS AND LINKERS

Microcomputer software design demands a highly sophisticated set of programming tools to maintain high productivity while permitting logic manipulations down to the hardware level. In response, Tek assembler/linker packages offer a feature set that streamlines the coding effort while retaining the power the user needs to implement machine-level operations.

Tek assembler packages consist of an assembler for a specific microprocessor, a sophisticated linker for locating code and a library generator for creating source code for object modules and reusing object modules previously created. Tektronix assemblers and linkers include many features that are normally only associated with high-level coding. The user can create sophisticated macro statements that provide high-level coding power within the assembly process.

The INCLUDE assembler directive can be used to include other files containing assembler source, data types, constants, and variables. Conditionals using Boolean expressions are available to help control the assembly process. In addition, Tek assemblers all share the same base, which means once users learn a Tek assembler they can move from one microprocessor to another with a minimum of learning time.

# Design Environment

**Multiple Hardware Platforms**

**UNIX/ULTRIX/VMS/PC DOS Support**

**Integrated Communications Packages**

**Common User Interface**

To support your engineering environment, Tektronix has tailored tools to work in many different environments. By supporting the VAX line from MicroVAX through VAX 8600 on both VMS and ULTRIX, the IBM PC, and Tek's own 856X workstations, you can choose the environment that best fits your needs.

## HOST ENVIRONMENTS

No matter what the size and scope of your engineering operations, Tek provides a solid hardware and software foundation for your microcomputer design tool set, supporting a wide range of 8-bit and 16-bit microprocessors. Tek SDP offers a variety of software design engineering environments:

- Tek code generation tools running on the 856X Multi-User Software Development Units and code execution on the 8540A or TekMate Microprocessor Support Systems.
- Tek code generation tools running on DEC VAX minicomputers, from the new MicroVAX II to powerful 8600, and code execution on the 8540A or TekMate Microprocessor Support Systems.
- Code generation tools, including assemblers and compilers developed by Microtec Research, Inc. on the IBM PC/XT/AT with download and debug communication to the 8540A or TekMate Microprocessor Support Systems.
- Debug communication to the 8540A from the Apollo workstation.

## 856X FAMILY

The 856X Multi-User Development Systems Series, consisting of the 8561, 8560 and 8562, is designed to be 100% software compatible and hardware upgradable.

The TNIX Operating System present on all members of the 856X Series is derived from AT&T Bell Laboratories UNIX Operating System Version 7. TNIX provides all the powerful features of UNIX, to support a team-oriented software design environment, including multi-tasking, hierarchical file system, electronic mail, MAKE for automated software creation, and SCCS for version control.

The 8561 is a powerful, entry-level software development system supporting one or two users. It offers an LSI-11/23 CPU, a 15 Mbyte hard disk, a 1 Mbyte flexible disk, 256 kbyte of RAM memory, two user ports, and two line printer ports. This basic system can be easily upgraded within the same mainframe to an LSI-11/73 CPU, 55 Mbyte of hard disk, 512 kbyte or 1 Mbyte of RAM memory, a GPIB interface for disk backup, and four or eight user ports. Each 8561 user port can support either a standard CRT terminal, a Tektronix 410X Color Terminal, or a Tektronix 8540A or TekMate Microprocessor Support Systems designed specifically to handle hardware/software integration tasks through real time emulation.

The 8560 offers a medium cost/performance software development system for four users. The same software design tools offered for the 8561 are available on the 8560 and the 8560 is also upgradable. A standard 8560 offers an LSI-11/73 CPU, a 40 Mbyte hard disk, a 1 Mbyte flexible disk, 256 kbyte of RAM memory, four user ports, and two line printer ports. The 8560 can be easily upgraded within the same mainframe to 80 Mbyte of hard disk and 1 Mbyte of RAM memory.

The 8562 is a high performance software development system which supports up to eight users. Compatible with the 8561 and 8560, the 8562 offers an LSI-11/73 CPU, 40 Mbyte hard disk, a 1 Mbyte flexible disk, 1 Mbyte of RAM memory, eight user ports, and two line printer ports. The 8562 can be upgraded with a GPIB interface for disk backup, or 80 Mbytes of disk storage within the same mainframe.

## Tek/DEC SOFTWARE COMPATIBILITY

Tek offers powerful High Level Language tools, both Pascal and C LANDS packages, and many popular assemblers on Digital Equipment Corporation's VAX Series of computers using the VMS, UNIX or ULTRIX based operating systems. This Tek/DEC combination gives you a powerful series of options when configuring your design environment. You can run Tek software development tools on the VAX to produce executable object code, and easily download the code to a Tek 8540A or TekMate Microprocessor Support System to perform emulation/debug tasks. Tek supplies you with the software needed to make your VAX/8540A or VAX/TekMate combination function as a turn key system. In more advanced configurations, you can interface entire 856X/8540A or 856X/TekMate systems to the VAX to create a powerful distributed processing system with the VAX acting as the central manager.

Regardless if you start with the entry level 8561 or a VAX 8600, the Tek software tools will allow you to transport the programs you generate from one computer to another.

## ColorKey+ USER INTERFACE

ColorKey+ and the Tek 410X Color Graphic Terminals work together to give simple single key stroke access to the TNIX (TEK 856X Series) and DEC VAX/VMS or UNIX/ULTRIX operating system and Tek's microcomputer design tools. ColorKey+, standard with the 856X Series, is offered as an optional package on the VAX.

The color coding and graphically defined soft keys guide the user through the system with a minimum of effort or knowledge.

The use of color and soft keys minimize the time it takes new users to learn the operating system and emulation/debugging system. Soft keys simplify command entry and minimize keystrokes.

Soft key labels appear on the bottom of the screen and change as different operations are performed. Functions are arranged in a hierarchical manner, from major tools down to specific options for a selected command.

ColorKey+ is an intelligent interface. Parameters entered by the user are remembered and can be displayed as soft key options later. Previous commands can also be recalled, modified, and reissued.

If a user requires more information about a soft key option, ColorKey+ will offer a longer explanation. And, if users forget where they are in the soft key command tree, a Where-Am-I command graphically displays the command sequence and soft key levels.

As soft key commands are entered, ColorKey+ displays the actual commands required to perform the operation. Eventually, the user learns most of the system commands and can directly issue commands to the system instead of using the soft keys.

ColorKey+ colors reduce user fatigue and increase productivity. Color maximizes readability of complex information and highlights different types of information.

## IBM PC

The IBM PC/XT/AT can be integrated with the 8540A or TekMate to form a powerful Microprocessor Development System. Tek is distributing Microtec assemblers and high level language compilers for code generation on the PC. These assemblers support Z80, NSC800, 6800/01/02, 6809, 8080, 8085, 8048, 1802, 9900, 68000/08/10, 8086/88, 80186/188, and Z8002. High level language compilers are available in Pascal or C for 8080/85, Z80 and NSC800; and PL/M for 8086/186/286. The Microtec tools produce object code that can be downloaded to the emulator in the 8540A or TekMate Microprocessor Support System for execution and symbolic debug.

## ICOM40A COMMUNICATIONS

The ICOM40A (Integrated Communications System) software package provides a means of communicating from the host to the 8540A emulation system. Code developed on the host with code generation tools can then be verified and debugged with the powerful emulation tools. ICOM40A allows remote access to 8540A's connected to a host. Both the host and 8540A operating systems can be accessed from a terminal connected only to the host. Commands can be intermixed as entered or in command files and ICOM will send the command to the appropriate system. Binary or hexadecimal format files can be downloaded from the host to the 8540A. Standard with the 856X Series host, ICOM40A is also currently available for the VAX host, VMS, UNIX and ULTRIX operating systems, the IBM PC/XT/AT, and Apollo workstation family of minicomputers. ICOM40A functionality has been included as a standard feature with the TekMate Microprocessor Support System.

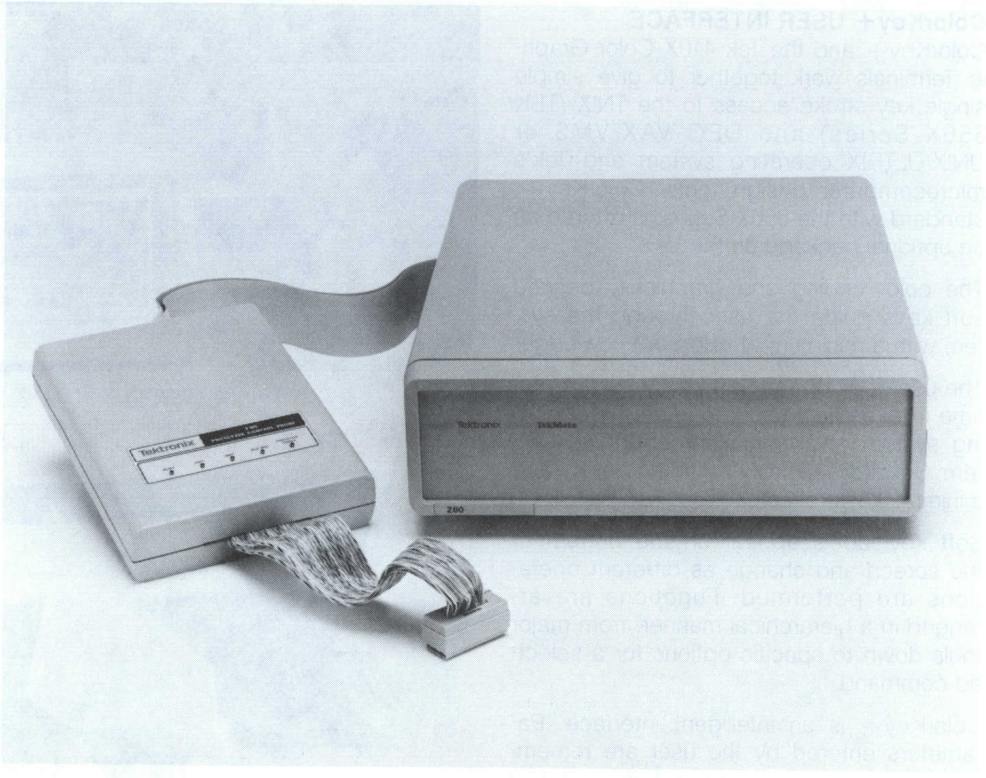
# Microprocessor Support Systems

**8-Bit and 16-Bit Quality Emulation**

**8540A Universal Systems**

**TekMate Low Cost 8-Bit Monolithic Systems**

Tektronix expands an extensive line of high quality emulation tools with TekMate, a low-cost monolithic 8-bit Microprocessor Support System. TekMate complements the 8540A Microprocessor Support Systems. For those needing high-performance, low-cost 8-bit support, TekMate fills your need. For those who need to eventually add 16-bit development capability, the 8540A is the system of choice. Supporting both 8-bit and 16-bit emulators, the modular 8540A can be easily configured for the support you need.




# TekMate®

**Microprocessor Support Systems**

**NON-STOP EMULATION to Allow the Full Use of the Emulation Analysis Tools During Emulation**

**HIGH PERFORMANCE to Provide the Analysis Tools Needed to get the Job Done Fast**

**LOW COST Monolithic 8-Bit System**

**EASE OF USE Designed in from the Start to Maximize Usability and Productivity**

TekMate is a high performance, low cost emulation system with hardware and software analysis for 8-bit microprocessors and microcontrollers. The Z80, 8085 and 6809 microprocessors are supported today. Contact your local SDP sales representative for future TekMate support such as the 68HC11.

## CHARACTERISTICS

To assure the user of getting the best dollar performance available for 8-bit microcontroller and microprocessor support, the TekMate Microprocessor Support System was designed with all desired emulation features standard including:

### EMULATION ENVIRONMENT

**Emulation Memory**

- 64 kbyte emulation memory.
- Prototype/emulation memory mappable on 256 byte boundaries.
- Examine, patch, fill, load, save memory functions.
- Full symbolic debug capability.
- Disassemble memory.
- Support for Tek language tools as well as other vendors.

**Register Trace**

- 16 selectable address trace ranges or values.
- Instruction disassembly during register trace.
- Uninterrupted real-time execution between traced instructions.
- Display and set register content.

**Real Time Trace**

- Nonstop Emulation
- 1024 line bus transaction trace buffer.
- Buffer contents available without stopping emulator.
- Complex Buffer trigger qualification
- Buffer can capture pretrigger, posttrigger, or center trigger data.
- Trigger configuration set without stopping emulator.

**Emulation Break Points**

- 16 break points can be set for either ADDRESS RANGES OR VALUES.
- Real Time Trace break point can be set to occur when the trace buffer acquisition is complete.
- External Trigger input.

**Three Emulation Modes**

See diagram on next page.

**Symbolic Debug**

- Full Symbolic capability.
- Virtual symbol table.
- User defined symbols can be created and stored during debug operation.

**8540A Compatible**

- Full service call support

**8540A Load File Support**

- Trigger In and Out.
- Trigger out on emulation breaks
  - Leading edge when break conditions are met.
  - Trailing edge when emulator is halted.
- Maskable trigger input to halt emulation.

**HOST SUPPORT**

Using standard RS-232 communications, emulation control software and language support tools are provided for the following hosts:

IBM PC.
VAX.
Tektronix 856X Series.

# 8540A

## Microprocessor Support System

### 8-Bit & 16-Bit Real-Time Emulation

### Modular Universal System

### Expansion Capability

The 8540A supports both 8-bit and 16-bit microprocessors. Modularity and universality are key features of the 8540A. The 8540A can be configured to meet your needs. Modular options include:

- Full Range of Microprocessor Support
- Program Memory—64 kbytes to 768 kbytes
- Trigger Trace Analyzer
- Memory Allocation Controller
- PROM Programmer Support
- Communication Options

**Real Time Emulation**

Real-time emulation is accomplished by executing code on a processor identical in function to the one targeted for the prototype hardware. The emulator processor is run under the control of powerful debug software that allows control and tracing of the code's execution. This debug software does not need to be linked into your code or use any of your memory or interrupt lines.

Tek's superior emulators allow your code to execute in real-time, with no wait states inserted or clock pulses stretched. This means the emulator is fully transparent to the user; therefore you do not spend time "working around" the development system.

**Trigger Trace Analyzer Captures Real-Time Events**

A powerful option to Tek emulators is the Trigger Trace Analyzer, which uses a high-speed trace buffer to capture real-time software and hardware logic events, with the prototype running at the design's full specified operating speed. Multiple word recognizers allow you to define sophisticated triggers when tracing code execution. And data qualification allows you to capture only the data you wish to see.

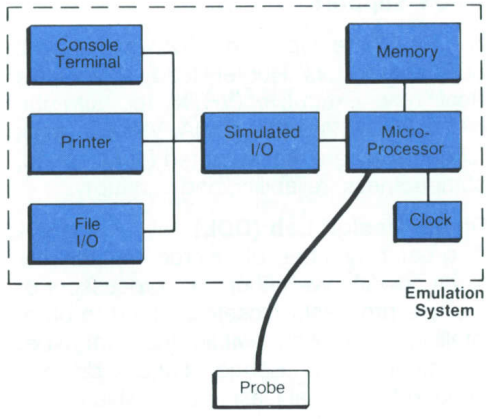
**Three Modes of Emulation**

Both the 8540A and TekMate systems enable you to incrementally integrate your prototype software and hardware. Starting with mode 0, you can do a majority of your software design without a prototype. Using Service Calls (SVCs) to simulate I/O, mode 0 debug can begin long before actual hardware is available.

Once prototype hardware is available, the designers gradually move from using emulation system resources to using prototype resources (mode 1). The final step is to use all of the prototype resources (mode 2) to execute the program. Because of the transparent nature of Tektronix emulators, your prototype will reliably perform in mode 2 as it will in actual operation with the emulator disconnected.

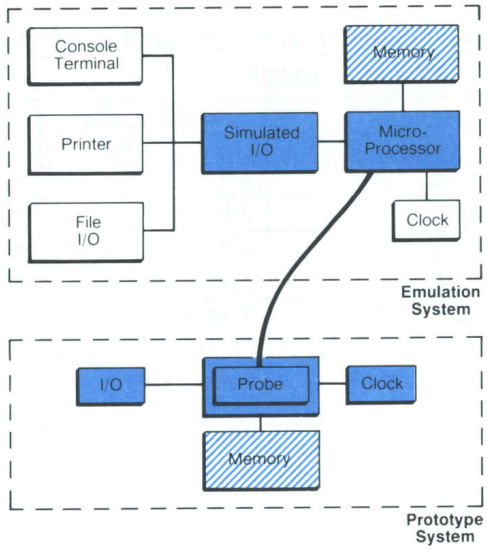
## 8540A/TekMate Modes of Emulation

### FULL FEATURE
### Phased Emulation — Mode 0



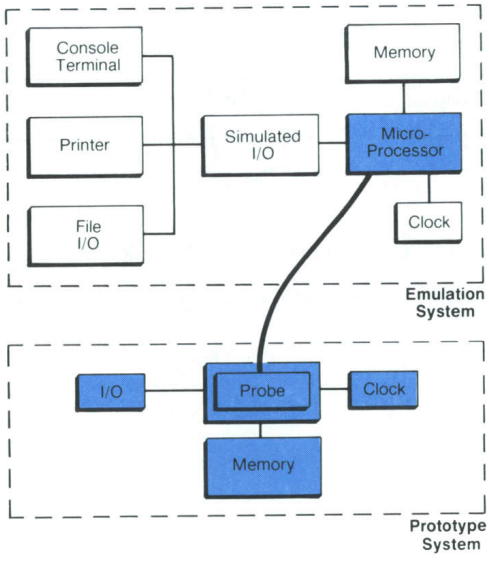

- Software Tested On Actual Microprocessor
- No Prototype Hardware Required
- Prototype I/O Interactions Are Simulated
- All Emulator Debug Functions Are Available

### FULL FEATURE
### Phased Emulation — Mode 1




- Prototype Software & Hardware Tested Together
  - — All Clock, I/O & Interrupts Tested
  - — Real-Time Environment
- Memory Substitution
  - — No PROMs To Program
  - — Can Debug Without Working Memory System
- Program is Transferred To Prototype Memory In Steps
- All Emulator Debug Functions Are Available

### FULL FEATURE
### Phased Emulation — Mode 2




- Final Test Of Hardware & Software
- All Prototype Memory Tested
  - — PROM, ROM, Etc.
  - — Dynamic Or Static RAM
- All Emulator Debug Features Available

## 16-Bit Microprocessor Support

Tektronix SDP supports software development tools and emulation for the major 16-bit microprocessors. Code generation tools, including Pascal and C LANDS packages, assemblers and compilers, are available on a variety of hosts with download capability and debug communication to the 8540A Integration Unit for code execution.

Full coverage, including assembler, Pascal and C LANDS, and emulation for the Motorola 68000 Family is available whether you use as a host the 856X Series, the VAX minicomputers or the IBM PC. SDP supports the Intel 8086/8088 with the 8087 floating point co-processor, as well as 80186/80188 chips with emulation and LANDS, both Pascal and C. New to the product line this year is support for the NEC V20/70108 and V30/70116 chips. Emulation tools are available on the 8540A with an NEC mnemonic assembler, as well as code-compatible 8086 software tools.

### RTOS Support

For Real-Time Operating System support, SDP also offers Hunter-Ready's Versatile Real Time Executive (VRTX) for both the 68000 Family and the 1750A. VRTX is a 6 k "silicon software" kernel noted for its speed, compactness, reliability, and versatility.

### Digital Design Lab (DDL)

A greater number of microcomputer designs now involve either dual processors or a single processor closely coupled to other intelligent hardware within the prototype. Tek meets the challenge of these designs through the Digital Design Lab, which combines the power of the Tektronix 856X/8540A Microcomputer Development System with the Tektronix DAS 9100 Digital Analysis System.

Through a single terminal interface, the user has complete control of both systems. An 8540A emulator controls one processor's execution while the DAS 9100 monitors the second intelligent chip. The real-time data flow from these two sources is state stamped as it is stored in memory. The data can then be correlated in a time-synchronized manner for display and analysis. This time correlation capability allows you to see the cause and effect relationships between the two circuit elements being debugged. The result is a powerful insight into separate, but related data flows within the same prototype system.



### 8-BIT AND 16-BIT SUPPORT CHART

| | HOST | | | | EMULATION | |
|---|---|---|---|---|---|---|
| MICROPROCESSOR | 856X | VAX/VMS | VAX/UNIX ULTRIX | IBM PC | TEKMATE | 8540A |
| Z80/Z80 CMOS | ASM | ASM | ASM | ASM, PAS, C | EZ80 | VZ80 |
| 6809 | ASM | ASM | ASM | ASM | E6809 | V6809 |
| 8085A | ASM | ASM | ASM | ASM, PAS, C | E8085 | V8085 |
| NSC800 | ASM | ASM | ASM | ASM, PAS, C | | VNSC800 |
| 68000 | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM | | V68000A |
| 68008 | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM | | V68008 |
| 68010 | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM | | V68010 |
| 8086/87<br>8088/87 | ASM, PLANDS | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM, PL/M | | V8086<br>V8088 |
| 80186/80188 | ASM, PLANDS | ASM, PLANDS, CLANDS | ASM, PLANDS, CLANDS | ASM, PL/M | | V80186<br>V80188 |
| 1750A, F9450 | ASM | ASM | | | | V1750, OP 30 |
| Z8001/2 | ASM, PLANDS | | | ASM | | 8300E20 |
| 9900/9989 | ASM | | | ASM | | 8300E33 |
| 8048 | ASM | | | ASM | | 8300E10 |
| 70116/V30<br>70108/V20 | ASM | ASM | ASM | | | 8300E41 |
| 7800 Family | ASM | | | | | 8300E34 |

ASM—Assembler/Linker package
C—C Compiler
CLANDS—C LANDS package; includes C LDE, C Compiler, ICS, C Debug, Assembler/Linker package
PAS—Pascal Compiler
PLANDS— Pascal LANDS package; includes P LDE, Pascal Compiler, ICS, Pascal Debug, Assembler/Linker package
PL/M—PL/M Compiler

# Support for Aerospace/Defense Applications

**Real Time Software Testing in the Target System.**

**High Order Language Development Systems; Pascal and Ada*1**

**856X/VAX Host Support**

**Worldwide Service and Support**

*1 Ada is a registered trademark of the Department of Defense.

The use of microprocessors in military applications has mushroomed in the past few years. Military applications usually have strict reliability and environmental requirements that prevent the use of commercially popular microprocessors. Tektronix is addressing the need to support microprocessors used in military applications by offering support for the following processors; Z8000 including the Z8001 and Z8002, TMS 9900, SBP 9900, SBP 9989, SBR 9000 and Mil-Std 1750A processors including the F9450.

### Mil-Std 1750A Background

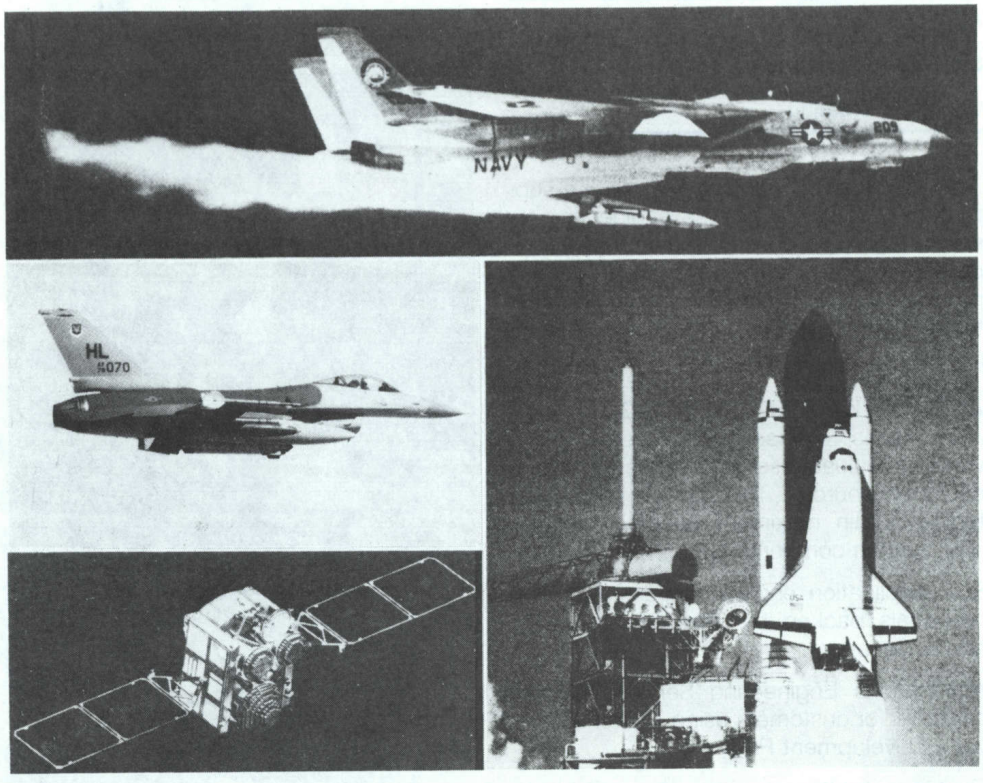
In an effort to control the spiraling cost of developing software, the military community has instituted several standardization programs. One of these, Mil-Std 1750A was developed by the United States Air Force and defines the standard 16-bit processor to be used in all embedded weapons systems. Mil-Std 1750A standard specifies the ISA (Instruction Set Architecture) but not the physical, electrical or performance characteristics of the processor. This allows processors to be implemented as several boards, a single board or a microprocessor chip. Since the ISA is the same however, application software can be transported from one processor to another without modification.

### Mil-Std 1750A Support System

The Tektronix 1750A support system includes tools for developing and debugging software for embedded applications. The package includes a Tektronix assembler/linker system for software development and a full function emulation system for testing the software with or without the target system.

The 1750 assembler/linker package provides all of the functions to support machine level program development. The assembler supports either the Mil-Std 1750 instruction mnemonics or the IEEE version. The package can be hosted on the Tektronix 856X Series, or the VAX Series with VMS.

For embedded applications requiring a real-time operating kernel, Tektronix is offering the VRTX/1750*2 and VMX/1750 R & D packages. VRTX and VMX are off-the-shelf software components that can be used directly in the embedded system to coordinate real-time tasks. These systems are available in EPROM that can be used directly in the target environment, or on Tektronix 856X disk media.




*Photos: Department of Defense and NASA*

The Mil-Std 1750A emulator supports the unique requirements for integrating software into the target environment. The emulation system can be used to test software written in assembly, or in a high-order language such as Ada, JOVIAL or CMS-II. A series of probe adaptors are available for connection into the target processor environment including an in-circuit probe for the F9450 microprocessor. These probe adaptors can be used to connect the emulator to a chip socket (F9450), a board, a bus or to the CPU's mechanical enclosure.

If the target processor isn't available, then the Mikros SEU (Software Execution Unit) can be used in its place. The Mikros SEU provides a Mil-Std 1750A compliant environment for testing and debugging software. Programs can be loaded and tested on the Mikros processor before they are transferred to the target environment. This frees the host from time consuming (and slow) simulations.

*2 VRTX is a registered trademark of Hunter-Ready Inc.

### Mil-Std 1815A (Ada) Support

An Ada language system will be available to support Mil-Std 1750A applications. This system is being modeled after the Tektronix LANDS software development environment explained on page 91. Your Tektronix sales representative can give you the details.

### Z8000 Support Systems

Z8000 processors are used in a wide variety of military applications, and are currently available to meet military reliability requirements like Mil-Std 883 screening.

Tektronix supports both the Z8001 segmented version, and the Z8002 non-segmented versions of the processor. An assembler/linker system is available to support machine language programming requirements, and a Pascal LANDS package for high-order language programming. Both of these software systems are supported on the Tektronix 856X Series hosts. The Pascal LANDS package is an integrated set of language tools consisting of a Pascal language directed editor, a Pascal compiler and high-level debugging system. See page 91 for more information.

The emulator supports in circuit probes for either the Z8001 or Z8002 microprocessors. The emulator system provides trace, breakpoint and memory substitution in the actual target environment. The emulator also interacts with the Pascal LANDS software system so Pascal programs can be debugged from the HLL (High Order Language) source.

### 9900 Support System

9900 Series processors are used in aerospace applications where radiation tolerance is a requirement. The Tektronix 9900 support package includes support for the TMS 9900, SBP 9900, SBP 9989 and software support for the SBR 9000.

The 9900 assembler/linker package supports machine level programming requirements. This system is hosted on the Tektronix 856X Series. Symbol tables are available to the emulation system to support fully symbolic control during the debugging process.

# Services

**Applications Engineering**

**Software Subscription Service**

**Customer Training**

After purchasing SDP Tools, extensive support is available. Dedicated engineering resources are available for many custom applications, Software Subscription Service protects your software investment, and customer training helps you quickly become productive on Tektronix products.

## APPLICATIONS ENGINEERING

Applications Engineering Services offers a variety of valuable services that supplement customer sources. This service helps customers attain maximum benefit from Tek SDP system components.

SDP application engineers are skilled professionals backed by Tektronix resources and experience.

Applications Engineering Services is only available for customers using Tektronix Software Development Products.

On-site consultive services are available to assist customers with development programs. This consultation is valuable for meeting critical program schedules. AES consultation optimizes the operation of Tek SDP software and hardware.

Application engineers can help trace and debug problems within a software/hardware system or problems encountered during software/hardware integration.

Tektronix can assist you with unusual interfacing challenges requiring in-depth knowledge of Tek software and hardware.

Applications engineers can also give you expert consultation in software/hardware design and integration using Tek Software Development Products. AES-01 price quotes are available by the hour, day or week.

## SOFTWARE SUBSCRIPTION SERVICE

The Tektronix SSS (Software Subscription Service) automatically provides new releases of SDP licensed software products as well as associated updates to software documentation.

### Product Updates

New software releases are sent out as product updates occur. This program allows customers to maintain their equipment at the latest software revision level.

### Applications and Information

Subscribers to SSS receive User Group News, a publication with information on application ideas, new product announcements, and product support.

Support under SSS is provided free for the first three months from the date of shipment and can be extended after that for an annual fee. Customers must identify a person and/or department responsible for receiving software updates and for maintaining the software's integrity.

The SSS should be purchased for all SDP software because of product interaction.

## CUSTOMER TRAINING

Tektronix customer training helps customers make full productive use of their development tools. Training modules are for individual self-training or can be conducted by an SDP representative. Training is done at customers' sites using their development tools.

Through training, customers will learn development tool capabilities and techniques; and will receive an overview of product documentation. Tektronix SDP specialists are available to conduct all training sessions.

Tektronix training sessions are tailored to address customers' specific development tools. Training means that new users will be productive in less time than they would be by trial and error. Experienced users will remain productive without disrupting their efforts with demands for training.

SDP customer training is available in most locations. Price quotes available upon request.

## ORDERING INFORMATION

### V-SYSTEMS

The V-Systems from Tektronix are systems designed to provide complete hardware and software support for design engineers needing the highest quality design tools available. The V-Systems are configured to integrate with an existing host computer, an 856X Series, a VAX computer or IBM PC/AT/XT, and to include all the hardware and software required to do so.

**Included** with the V-Systems are Tektronix' 8540A Integration Unit, 16-bit emulation support (emulator and probe) with 128 kbyte memory or 8-bit emulation support with 64 kbyte memory, Trigger Trace Analyzer, and, as an option, Tektronix' unique LANDS for high-level language support. LANDS is available for 8086 and 68000 Families for Pascal or C and includes a Language-Directed Editor, Compiler, Integration Control System, High Level Debug, Assembler, Linker, and ICOM40A for supporting VAX computers.

| | |
|---|---|
| **V68000A** Emulation Support | **$24,900** |
| **V68008** Emulation Support | **$24,900** |
| **V68010** Emulation Support | **$24,900** |

**OPTIONS**

| | |
|---|---|
| **Option 02** — MAC Board. | **+$2,500** |
| **Option 03** — TTA 8-Bit External LA Probe. | **+$1,000** |
| **Option 04** — Comm I/F for 8540A. | **+$400** |
| **Option 1A** — P-LANDS Support for 856X. | **+$9,000** |
| **Option 1C** — P-LANDS VAX UNIX Reel Mag Tape with ICOM40A. | **+$12,000** |
| **Option 1F** — P-LANDS VAX VMS Reel Mag Tape with ICOM40A. | **+$12,000** |
| **Option 2A** — C-LANDS Support for 856X. | **+$9,000** |
| **Option 2C** — C-LANDS VAX UNIX Reel Mag Tape. | **+$12,000** |
| **Option 2F** — C-LANDS VAX VMS Reel Mag Tape with ICOM40A. | **+$12,000** |

| | |
|---|---|
| **V8086** Emulation Support | **$24,900** |
| **V8088** Emulation Support | **$24,900** |
| **V80186** Emulation Support | **$24,900** |
| **V80188** Emulation Support | **$24,900** |

**OPTIONS**

| | |
|---|---|
| **Option 03** — TTA 8-Bit External LA Probe. | **+$1,000** |
| **Option 04** — COMM I/F for 8540A. | **+$400** |
| **Option 1A** — P-LANDS Support for 856X. | **+$9,000** |
| **Option 1C** — P-LANDS VAX UNIX Reel Mag Tape with ICOM40A. | **+$12,000** |
| **Option 1F** — P-LANDS VAX VMS Reel Mag Tape with ICOM40A. | **+$12,000** |
| **Option 2C** — C-LANDS VAX UNIX Reel Mag Tape. | **+$12,000** |
| **Option 2F** — C-LANDS VAX VMS Reel Mag Tape with ICOM40A. | **+$12,000** |

| | |
|---|---|
| **V1750A** Emulation Support | **$33,500** |

**OPTIONS**

| | |
|---|---|
| **Option 03** — TTA 8-Bit External LA Probe. | **+$1,000** |
| **Option 1A** — Assembler, 856X. | **+$2,000** |
| **Option 1F** — Assembler, VAX VMS Reel Mag Tape. | **+$4,000** |
| **Option 3A** — PIA W/Flying Leads, Clips. | **+$750** |
| **Option 3B** — PIA W/Flying Leads, Pigtail. | **+$650** |
| **Option 3C** — PIA Euro-Card Connector. | **+$750** |
| **Option 3D** — PIA, F9450. | **$1,500** |
| **85M1750** Software Execution Unit | **$13,000** |

| | |
|---|---|
| **VZ80** Emulation Support | **$13,900** |
| **V8085** Emulation Support | **$13,900** |
| **V6809** Emulation Support | **$13,900** |
| **VNSC800** Emulation Support | **$13,900** |

**OPTIONS**

| | |
|---|---|
| **Option 03** — TTA Back Panel and Probe. | **+$1,000** |
| **Option 04** — Communications Interface for 8540A. | **+$400** |
| **Option 1A** — Assembler for 856X. | **+$1,700** |
| **Option 1C** — Assembler for VAX UNIX Reel Mag Tape. | **+$2,500** |
| **Option 1F** — Assembler for VAX VMS Reel Mag Tape. | **+$2,500** |

### 856140 SYSTEMS

856140A Systems include the assembler, emulator, probe and firmware, 856X Multi-user Software Development Unit, 4105A Color Graphics Terminal and an 8540A Integration Unit with 64 kbytes of memory.

| | |
|---|---|
| **856140A** Z80 Development System | **$29,700** |
| **Includes:** Items listed above. | |
| **856140B** 8085 Development System | **$29,700** |
| **856140E** 6809 Development System | **$29,700** |
| **856140F** NSC800 Development System | **$29,700** |
| **856140H** 7809/8/7 Development System | **$30,700** |
| **856140J** 7810/11/16 Development System | **$30,700** |
| **856140K** 78C05/06 Development System | **$29,700** |

**OPTIONS**

| | |
|---|---|
| **Option 01** — Replace 8561 with 8560. | **+$6,000** |
| **Option 02** — 512 kbyte Memory for 856X. | **+$2,000** |
| **Option 03** — 1 Mbyte Memory for 856X. | **+$5,900** |
| **Option 06** — Trigger Trace Analyzer with F/W. | **+$4,500** |
| **Option 08** — Option 06 without Interface Probe | **$3,500** |
| **Option 10** — LSI 11/73 CPU with Floating Point. | **+$2,000** |

### MICROPROCESSOR SUPPORT SYSTEMS

**TekMate Emulation Systems**

The TekMate Emulation systems include mainframe, emulator and probe. TekMate Software is required.

| | |
|---|---|
| **EZ80** Z80 Emulation System | **$8,900** |
| **EZ6809** 6809 Emulation System | **$8,900** |
| **EZ8085** 8085 Emulation System | **$8,900** |
| **SZ80** Z80 TekMate Software | **$10** |
| **S6809** 6809 TekMate Software | **$10** |
| **S8085** 8085 TekMate Software | **$10** |

**OPTIONS**

| | |
|---|---|
| **Option 1A** — 856X Support. | **+$190** |
| **Option 1F** — VMS Reel Mag Tape. | **+$440** |
| **Option 1Y** — IBM PC (5¼ Floppy). | **+$85** |

### 8540A EMULATION SYSTEM

| | |
|---|---|
| **8540A** Emulation System | **$9,900** |

Options Available

### 8540A EMULATORS AND PROBES

| | |
|---|---|
| **8300E04** Z80 Emulator | **$2,800** |
| **8300P04** Z80 Probe | **$1,500** |
| **8300P49** Z80CMOS Probe | **$1,500** |
| **8300E06** 8085A Emulator | **$2,800** |
| **8300P06** 8085A Probe | **$1,500** |
| **8300E10** MCS48 Emulator | **$2,800** |
| **8300P10** 8048 Probe | **$1,500** |
| **8300P11** 8021 Probe | **$400** |
| **8300P12** 8041A Probe | **$1,500** |
| **8300P13** 8022 Probe | **$1,500** |
| **8300E15** 8086/8088 Emulator | **$6,100** |
| **8300P17** 8086/87 Probe | **$3,000** |
| **8300P18** 8088/87 Probe | **$3,000** |
| **8300E20** Z8001/2 Emulator | **$4,400** |
| **8300P20** Z8001 Probe | **$2,300** |
| **8300P22** Z8002 Probe | **$2,300** |
| **8300E28** 68XX Emulator | **$3,900** |
| **8300P28** 6809 Probe | **$1,500** |
| **8300P29** 6801 Probe | **$1,800** |
| **8300P30** 68120 Probe | **$1,800** |
| **8300P31** 6809E Probe | **$1,800** |
| **8300E33** 9900/9989 Emulator | **$4,400** |
| **8300P33** SBP9900 Probe | **$2,100** |
| **8300P34** SBP9989 Probe | **$2,100** |
| **8300P35** TMS 9900 Probe | **$2,100** |
| **8300E34** NSC800, NEC7800 Emulator | **$2,800** |
| **8300P37** NSC-800 Probe | **$3,400** |
| **8300P41** 7807/08/09 Probe | **$3,400** |
| **8300P42** 7810/11/16 Probe | **$3,400** |
| **8300P43** 78C05/6 Probe | **$3,400** |
| **8300E36** 68XXX Emulator | **$4,800** |
| **8300P38** 68008 Probe | **$4,100** |
| **8300P39** 68000-A Probe | **$4,100** |
| **8300P40** 68010 Probe | **$4,100** |
| **8300E40** 80186/188 Emulator | **$5,100** |
| **8300P46** 80188 Probe | **$4,900** |
| **8300P50** 80186A Probe | **$4,900** |
| **8300E42** 1750A-1 Emulator | **$8,700** |
| **8300P53** 1750A-1 Probe | **$9,800** |

**OPTIONS (8300P53 ONLY)**

| | |
|---|---|
| **Option 3A** PIA W/Clips. | **+$750** |
| **Option 3B** PIA W/O Clips. | **+$650** |
| **Option 3C** PIA W/DIN Plug. | **+$750** |
| **Option 3D** PIA F9450. | **+$1,500** |

## MICROPROCESSOR DEVELOPMENT SYSTEMS

**8560** Multi-User Development System **$19,900**
**8561** Multi-User Development System **$13,900**

**OPTIONS**

**Option 02** — Floating Point Option. **+$500**
**Option 03** — (8560 only) 5-8 Ports. **+$5,000**
**Option 04** — GPIB Interface. **+$2,500**
**Option 07** — 1 Mbyte Memory. **+$4,900**
**Option 08** — (8561 Only) Four Total User Ports. **+$2,500**
**Option 09** — (8560 only) 80 Mbyte Disk. **+$6,000**
**Option 10** — LSI-11/73 CPU with Floating Point. **+$2,000**
**Option 47** — Rackmount Option. **+$125**

**8562** Multi-User Development System **$24,900**

**OPTIONS**

**Option 04** — GPIB Interface. **+$2,500**
**Option 09** — 80 Mbyte Total Disk Storage. **+$6,000**

### LAB SUPPORT

**DDL** Digital Design Lab Support **$10**

**OPTIONS**

**Option 1A** — 856X Support. **+$2,890**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$3,490**

### SYSTEM DESIGN TOOLS

**STRUCTA** Structured Analysis Tools **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$9,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$16,490**
**Option 1F** — VAX VMS Reel Mag Tape. **+$16,490**

### LANGUAGE DEVELOPMENT SOFTWARE

**LANDS**

**CLAN86** C-Language Development System for 8086/88/186/188 **$10**

**OPTIONS**

**Option 1C** — VAX UNIX Reel Mag Tape. **+$9,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$9,990**

**CLAN68K** C-Language Development System for 68000/08/10 **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$9,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$11,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$11,990**

**PLAN86** Pascal Language Development System for 8086/186 **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$8,990**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$9,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$9,990**

**PLAN68K** Pascal Language Development System for 68000/08/10 **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$9,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$11,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$11,990**

**PLANZ8K** Pascal Language Development System for Z8001/2 **$10**

**OPTION**

**Option 1A** — Support for 856X. **+$9,490**

### EDITORS

**CLDEDIT** C-Language Directed Editor **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$1,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$1,490**
**Option 1F** — VAX VMS Reel Mag Tape. **+$1,490**

**PLDEDIT** Pascal-Language Directed Editor **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$1,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$1,490**
**Option 1F** — VAX VMS Reel Mag Tape. **+$1,490**

### ASSEMBLERS

**AMZ80** Z80/NSC800 Assembler **$10**
**ASM68K** 68000/08/10 Assembler **$10**
**ASM6809** 6809 Assembler **$10**
**ASM8085** 8085 Assembler **$10**
**ASM8086** 8086/88 Assembler **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$1,690**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$2,490**
**Option 1F** — VAX VMS Reel Mag Tape. **+$2,490**

Options 1A, 1C, and 1F work with the five assemblers listed above.

**ASMZ8K** Z8001/2 Assembler **$10**
**ASM6800** 6800/01/02 Assembler **$10**
**ASM78C** 78C05/06 Assembler **$10**
**ASM7809** 7809/08/07 Assembler **$10**
**ASM7811** 7810/11/16 Assembler **$10**
**ASM8048** 8048 Assembler **$10**
**ASM8051** 8051 Assembler **$10**
**ASM9900** 9900/9989 Assembler **$10**

**OPTION**

**Option 1A** — Support for 856X. **+$1,690**

Option 1A works with the eight assemblers listed above.

**ASM1750** 1750 Assembler **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$2,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$4,990**

**IBM PC Assemblers**

**8-Bit** Assemblers for Z80, NSC800, 6800/1/2, 6809, 8080/8085, 8048, 1802, 9900 **$600-750**

**16-Bit** Assemblers for 68000/08/10, 8086/88/186/188, Z8002 **$1,025**

### COMPILERS AND DEBUGS

**CCC68K** 68000/08/10 C Compiler **$10**
**CDB68K** 68000/08/10 C Debug **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$3,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$4,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$4,990**

Options 1A, 1C, and 1F work with the Compiler and Debug listed above.

**CCC8086** 8086/88, 80186/188 C Compiler **$10**
**CDB8086** 8086/88, 80186/188 C Debug **$10**

**OPTIONS**

**Option 1C** — VAX UNIX Reel Mag Tape. **+$2,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$2,990**

**IBM PC Compilers**

Each compiler comes with an assembler, a linker, an object module librarian, and an object code converter.

**Pascal** Compilers for Z80/NSC800 and 8080/8085. PL/M Compiler for 8086/186/286. **$1,950**

**PASZ8K** Z8001/2 Pascal Compiler **$10**

**OPTION**

**Option 1A** — Support for 856X. **+$3,490**

**PDBZ8K** Z8001/2 Pascal Debug **$10**

**OPTION**

**Option 1A** — Support for 856X. **+$2,990**

**PAS68K** 68000/08/10 Pascal Compiler **$10**
**PDB68K** 68000/08/10 Pascal Debug **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$3,490**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$4,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$4,990**

Options 1A, 1C, and 1F work with the Compiler and Debug listed above.

**PAS8086** 8086/87/88/186/188 Pascal Compiler **$10**
**PDB8086** 8086/87/88/186/188 Pascal Debug **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$2,990**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$2,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$2,990**

Options 1A, 1C, and 1F work with the Compiler and Debug listed above.

### INTEGRATED COMMUNICATIONS SYSTEMS

**ICOM40A** Integrated Communications System for 8540A **$10**

**OPTIONS**

**Option 1C** — VAX UNIX Reel Mag Tape. **+$1,990**
**Option 1F** — VAX VMS Reel Mag Tape. **+$1,990**
**Option 1Y** — IBM PC (5¼ Floppy). **+$740**

**ICOMSRC** ICOM40A Source **$10**

**OPTION**

**Option 1C** — VAX UNIX Reel Mag Tape. **+$7,990**

**COLORKY** ColorKey+ User Interface **$10**

**OPTIONS**

**Option 1C** — VAX UNIX Reel Mag Tape. **+$1,490**
**Option 1F** — VAX VMS Reel Mag Tape. **+$1,490**

### REAL TIME OPERATING SYSTEM (RTOS)

**PVRX68K** PAS68K Interface to VRTX68K **$10**

**OPTIONS**

**Option 1A** — Support for 856X. **+$940**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$940**
**Option 1F** — VAX VMS Reel Mag Tape. **+$940**

**VRTX68K** H&R's Custom R&D RTOS for 68000 **$5,275**

**OPTIONS**

**Option 01** — H&R's RTOS Debugger (TRACER). **+$2,750**
**Option 08** — For 68008. **NC**
**Option 10** — For 68010. **NC**
**Option 1A** — Support for 856X. **+$250**
**Option 1C** — VAX UNIX Reel Mag Tape. **+$250**
**Option 1F** — VAX VMS Reel Mag Tape. **+$250**

**VRX1750, VRTX1750** R&D Package **$25,000**

**OPTION**

**Option 1A** — Support for 856X. **NC**

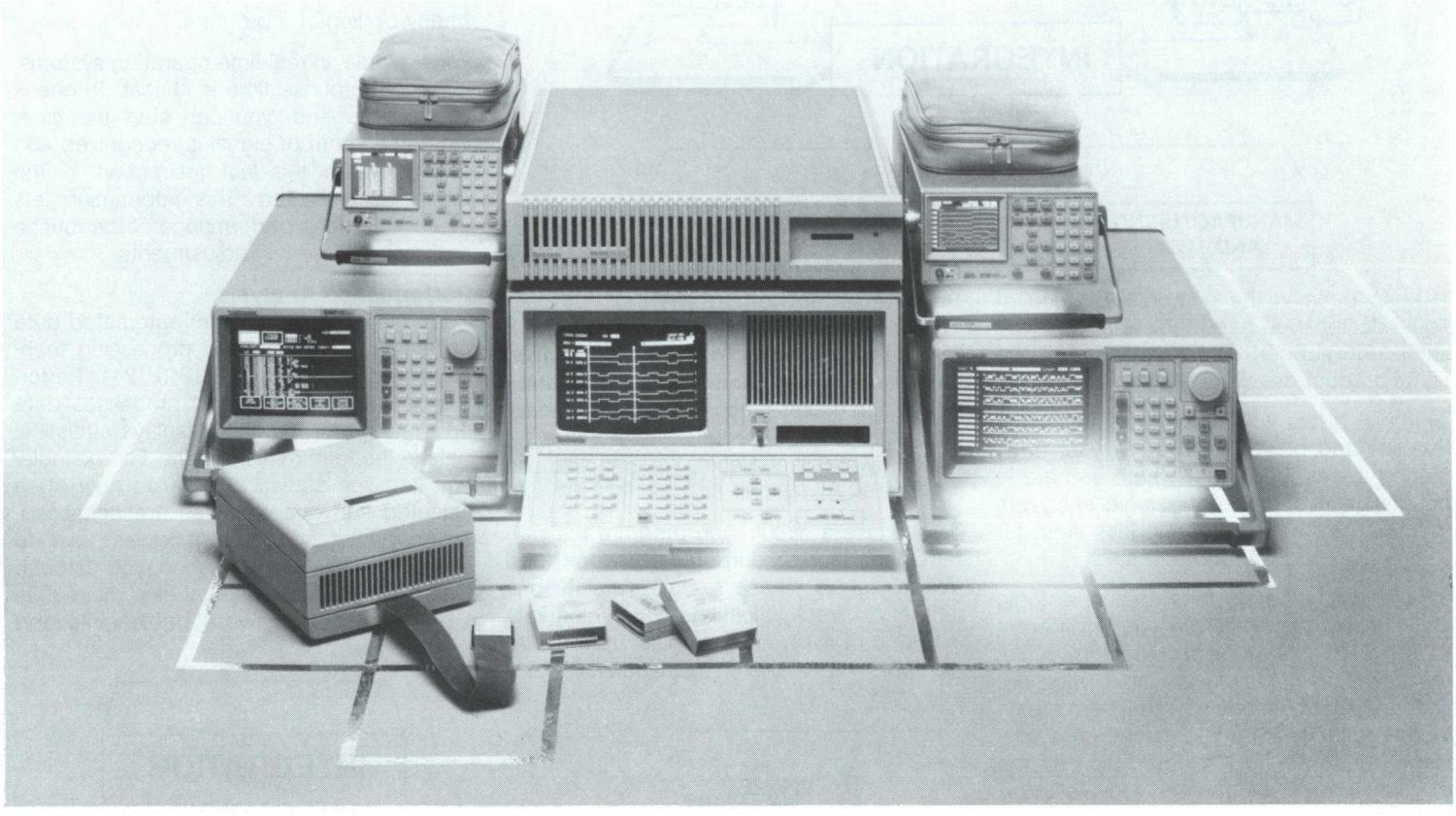
***WARRANTY-PLUS* SERVICE PLANS AVAILABLE ON MOST HARDWARE ITEMS**

Software Subscription Service available on most software items.

This is a partial listing of available products. For information concerning other configurations, options, peripherals, and available software contact your local SDP sales engineer.

SOFTWARE DEVELOPMENT

# LOGIC ANALYZER PRODUCTS



*The Tektronix Logic Analyzer Family includes the DAS 9100, the 1240/1241, the 338, and the 318 Logic Analyzers.*

Tektronix offers a broad family of logic analyzers in three product lines:

**DAS 9100**
The Digital Analysis System 9100 Series offers three mainframes, seven different data acquisition modules, four different pattern generation modules, tape cassette mass storage, systems interfaces, and microprocessor mnemonics. For high-speed applications, the DAS offers the fastest sample speed in the industry—2 GHz, for timing resolution of 500 ps.

**1200 Series**
Easily portable and rugged, the 1240 and color 1241 mainframes offer two types of data acquisition modules, microprocessor mnemonics, performance analysis, RAM/ROM pack mass storage, modular COMM pack system interfaces, and the industry's first true dual-timebase capability.

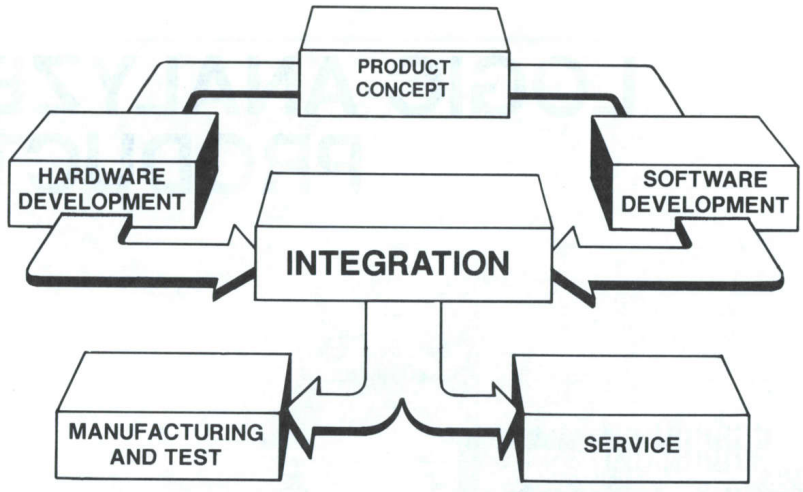
**300 Series**
When weight and size are of utmost importance, the 300 Series offers ultra-portability. Weighing only 11 lbs, the 308, 318, and 338 each offer state, timing, and serial analysis. The 308 also offers signature analysis. These three analyzers offer an unprecedented combination of performance, portability, and low price.

**Easy-to-Use**
All Tektronix logic analyzers are easy to use, because we believe the logic analyzer should allow you to concentrate on solving problems rather than learning to operate the analyzer. Clear screen displays, menu formatted operator interfaces, straightforward keyboard layouts, and simple, reliable mass storage media all contribute to the overall friendliness of the Tektronix logic analyzer family. Ease-of-use is further enhanced by such industry firsts as the color display in the DAS and the touch-screen soft keys in the 1240.

**Modular and Upgradable**
The DAS 9100 and 1240/1241 modular mainframes allow you to customize your logic analyzer to meet your application needs. And if your needs change, you can easily upgrade your DAS or 1240/1241 to keep pace with your new requirements.

## CONTENTS


| | |
|---|---|
| DAS 9100 Series Logic Analyzers | 104 |
| 1200 Series Logic Analyzers | 114 |
| Microprocessor Support | 122 |
| 300 Series Logic Analyzers | 124 |
| Logic Analyzer Probes and Accessories | 128 |
| 7A42 Logic Triggered Vertical Amplifier | 216 |




To keep pace in the competitive world of digital design, you need tools that give you consistent support in all phases of the digital product development cycle.

Tektronix offers logic analyzers with the flexibility and power to meet all your engineering needs, no matter where you are in the design cycle. Tektronix logic analyzers help you get the job done in less time, for less money, and with better results.

The following paragraphs describe logic analyzer features that help you in different phases of the product development cycle. The selection guide on the next page will help you select the analyzer that best meets your needs. For more information on a specific model, refer to the description on the following pages, or contact your Tektronix sales engineer.

### Clock Qualification

A digital bus often carries irrelevant data as well as data of interest. Clock qualification lets you filter out irrelevant data by combining the acquisition clock with one or more bus signals. For example, you could use clock qualifiers to ensure that the analyzer stores only DMA transactions.

### Event Timing

Timing relationships between signals are often critical. You might need to know how long a specific state lasts on one channel or on a bus. Or, you might need to know the elapsed time between two handshake signals. If you have an intermittent timing problem, you might want to trigger the analyzer only when timing parameters are exceeded.

### Glitch Triggering

When debugging prototypes, you often encounter signal glitches. To fully analyze the problem, you must be able to trigger on the glitch and isolate its occurrence.

### Pattern Generation

The DAS 9100 is the first logic analyzer with both acquisition and pattern generation (stimulation) in the same instrument. Pattern generation makes it possible to start debugging hardware before the software, or all of the hardware, is available. You can also use it to test VLSI devices.

To exercise a circuit, you program the pattern generator to output data, clock, and strobe signals. These signals simulate bus activity or directly stimulate circuit elements in the prototype. The signals from these elements can then be acquired and analyzed.

### Mnemonic Disassembly

To simplify the debugging of microprocessor-based systems, the DAS 9100 and the 1240/1241 feature a wide variety of single-plug probe connections and mnemonic disassembly software for popular processors and buses. Setup is easy: Programmed tapes or ROM packs automatically customize the analyzer to support the specific processor.

For nonstandard processor designs, the DAS 9100 lets you design your own unique disassembly. This feature supports disassembly for custom or proprietary processors while maintaining complete confidentiality.

### Tracking Complex Program Flow

In microprocessor-based systems, more than a simple sequential trigger is often required. You need the ability to track a complex sequence of software events through various jumps, loops, and branches. To do this, you need powerful and flexible word recognition that can track program flow through multiple decision points.

### Measuring Software Execution Time

Efficient software performance depends, in large part, on minimizing the execution times of various routines. The DAS 9100 and the 1240/1241 provide counter/timer functions that let you monitor the execution time of any portion of a program.

For example, in real-time operating systems, interrupt response time is critical. To check execution speed, you can start the timer when the interrupt signal is recognized and stop it when the last instruction in the routine is executed. This information lets you evaluate the performance of the routine and make necessary adjustments.

### Performance Analysis

Performance analysis is an automated data collection, reduction, and processing technique available with the 1240/1241. Performance analysis sorts and processes data on system activity, then displays statistical data in the form of histograms. For example, you can see statistical data on how often selected software modules are accessed, or on how long those modules take to execute. With this information, you can see where the processor is spending most of its time, and spot software bottlenecks and inefficiencies.

### Demultiplexing

Both the DAS 9100 and the 1240/1241 offer demultiplexing with single-probe connections for simple setup. In a demultiplexed display, different types of data are clearly separated and easy to follow.

For example, in order to verify read or write bus cycle timing in the 8086, you must use demultiplexing to separate the address, data, and bus cycle status signals.

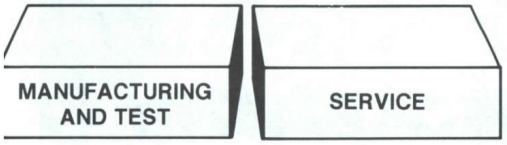
### Dual Time Bases

The 1240/1241 offer two independent, synchronous, time-aligned time bases. This feature lets you monitor the interaction of hardware and software, or track the interaction of multiple functional modules.

One example is a dual-processor system where the processors have different buses and run from unrelated clocks. A single timebase can be used to debug either of the modules separately, but you need dual synchronous time bases to monitor both processors and the interaction of the buses. The 1240/1241 data display shows you a time-aligned picture of the data flow from both modules.

### Trigger Arming

The DAS 9100, 1240, and 1241 feature trigger arming. This technique lets you simultaneously acquire high-speed, asynchronous control signals and low-speed, synchronous bus signals. Data is displayed in a time-correlated fashion, with high-speed data displayed in correct reference to low-speed data. The advantage to this technique is that it allows you to use software flow to pinpoint problem areas in the control logic which might otherwise be difficult to locate.




### Pattern Generation

Pattern generation combines with acquisition in the DAS 9100 to drive the test environment for your products or subassemblies. The DAS is also an effective tool for functional testing and verification of VLSI components.

### Remote Control

Many testing applications call for your logic analyzer to interface with a larger computer system. Tektronix analyzers can be remotely operated over RS-232C or GPIB interfaces. This makes them ideally suited for automated test environments.

### Mass Storage

The DAS 9100 and the 1240/1241 feature simple, rugged, mass storage media. You can store setups and memories for later use or for transport to another instrument. Storage is controlled from easy-to-use menus. You can easily name files to suit your needs, and save and restore them quickly.

### Master/Slave

The DAS 9100 and the 1240/1241 both provide master/slave support. This capability lets one analyzer communicate with another analyzer at a remote location over telephone lines. Major computer companies have established master/slave as an effective service technique. Maintenance personnel can use master/slave to solve complex problems at remote sites without ever having to leave the office.

**The 7A42 Logic Triggered Vertical Amplifier combines oscilloscope and logic analyzer functions. Refer to page 216 for more information.**

## SELECTION GUIDE

The right logic analyzer for you is the one that best meets the needs of your applications, present and future. To assist you in finding your optimum solution, the following selection guide compares some of the capabilities of the Tektronix logic analyzer family. For more information on a specific model, refer to the description on the following pages, or contact your Tektronix sales engineer.

| APPLICATION/FEATURE | DAS 9100 | 1240/1241 | 318 | 338 | 308 |
|---|---|---|---|---|---|
| **Hardware Analysis** | 10, 25 100, 660 2 GHz | 50, 100 | 50 | 20 | 20 |
| Asynchronous acquisition rate, in MHz | | | | | |
| Trigger on simple program execution | ✓ | ✓ | ✓ | ✓ | ✓ |
| Measure event time/state count | ✓ | ✓ | | | |
| Trigger on event time/state count | | ✓ | | | |
| Clock qualification | ✓ | ✓ | ✓ | ✓ | ✓ |
| Simultaneous state/timing acquisition | ✓ | ✓ | | | |
| Glitch capture | ✓ | ✓ | ✓ | ✓ | ✓ |
| Glitch triggering | ✓ | ✓ | ✓ | ✓ | |
| Acquisition and reference memories | ✓ | ✓ | ✓ | ✓ | ✓ |
| Compare acquisition/reference memory | ✓ | ✓ | ✓ | ✓ | ✓ |
| Trigger input and output | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pattern generation | ✓ | | | | |
| **Software Analysis** | 10, 25 100, 330 | 50 | 50 | 20 | 20 |
| Synchronous acquisition rate, in MHz | | | | | |
| Trigger on complex program flow | ✓ | ✓ | ✓ | ✓ | |
| Measure execution time/state count | ✓ | ✓ | | | |
| Trigger on execution time/state count | | ✓ | | | |
| Data qualification | ✓ | ✓ | | | |
| Microprocessor mnemonics | ✓ | ✓ | | | |
| User-definable mnemonics | ✓ | | | | |
| Performance Analysis | | ✓ | | | |
| Analyze serial data to 9.6 kbaud | | | ✓ | ✓ | ✓ |
| Analyze serial data to 19.2 kbaud | | | ✓ | ✓ | |
| Analyze GPIB transactions | ✓ | ✓ | | | |
| **Hardware/Software Integration** | | | | | |
| Dual synchronous time bases | | ✓ | | | |
| Trigger arming | ✓ | ✓ | | | |
| Time-aligned state and timing displays | ✓ | ✓ | | | |
| Demultiplexing | ✓ | ✓ | | | |
| **VLSI Testing** | ✓ | | | | |
| **Manufacturing and Test** | RS-232 GPIB | RS-232 GPIB | RS-232 | RS-232 | |
| Controller interface | | | | | |
| Pattern generation and acquisition | ✓ | | | | |
| Easily transportable storage media | Tape | Pack | | | |
| Programmable via RS-232C | ✓ | ✓ | ✓ | ✓ | |
| Programmable via GPIB | ✓ | ✓ | | | |
| Video out for hard copy or monitor | ✓ | ✓ | ✓ | ✓ | |
| Line printer output | ✓ | ✓ | | | |
| **Service** | | | | | |
| First line on-site | | ✓ | ✓ | ✓ | ✓ |
| Permanent on-site | ✓ | ✓ | ✓ | ✓ | ✓ |
| Depot level | ✓ | ✓ | ✓ | ✓ | ✓ |
| Remote control via master/slave | ✓ | ✓ | | | |
| Remote control via host controller | ✓ | ✓ | ✓ | ✓ | |
| Signature analysis | | | | | ✓ |
| **Page** | 104 | 114 | 124 | 124 | 127 |
| **Prices Begin At:** | $13,470 | $4,500/$6,000 | $5,300 | $5,800 | $3,950 |

# DAS 9100 Series

## Digital Analysis System

GPIB IEEE-488

The DAS 9100 Series Option 06 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Color Display Enhances Ease-of-Use and Increases Productivity**

**Ten Standard Application Configurations Available or Custom Design Your Own System**

**Acquisition Speeds to 2 GHz (500 ps)**

**Data Widths to 104 Channels**

**Pattern Generation Up to 192 Channels at 50 MHz**

**DesignLink® Software Links DAS 9100 to a Host for Bench-Top VLSI Functional Testing**

**Disassembly Support for Over 30 Microprocessors and Buses**

**Memory Depths from 512 to 8032 Bits Per Channel**

**Patented EDM Disassembles Proprietary Processors and Buses**

**Select Triggering to 16 Levels**

**Patented Time Correlation of High-Speed and Low-Speed Data**

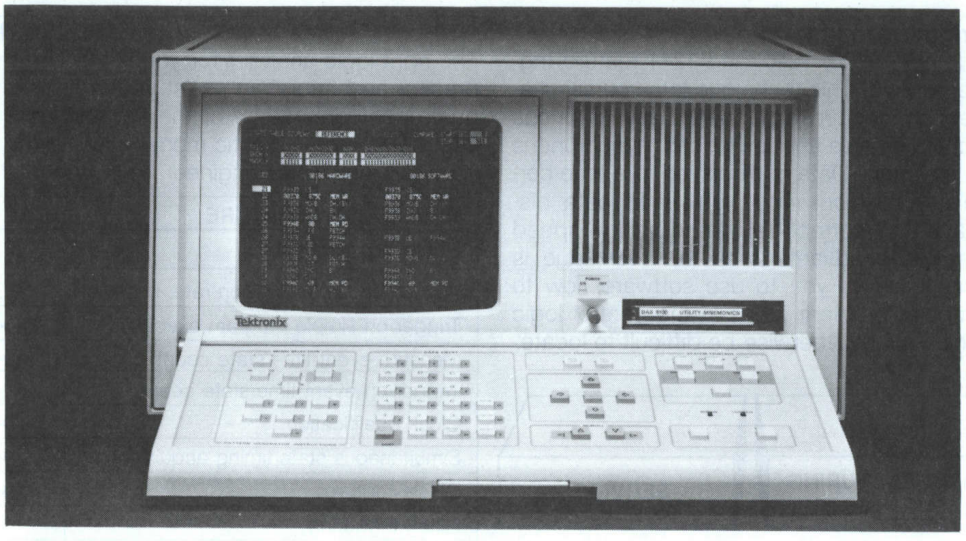
**Separate Glitch Memory**

**State-Table and Timing Diagrams Displayed for all Channels**

**Pattern Generation to Simulate Hardware or Software**

**Supports GPIB, RS-232, Hard-Copy Units and Serial Line Printers**

**Tape Drive Stores Patterns and Instrument Set-Ups for Future Use**




### The Industry Standard

The DAS 9100 Series Digital Analysis System has set the industry standard for virtually all aspects of logic analysis. Its modular mainframe accepts a wide assortment of both data acquisition and pattern generation modules to fit your application needs. You get performance combinations unavailable in any other logic analyzer, including data widths to 104 channels and acquisition speeds up to 2 GHz. Another DAS 9100 innovation is the inclusion of pattern generation modules, up to 192 channels, which can be used in concert with data acquisition modules to perform sophisticated test procedures, such as VLSI Functional Test.

### The Leader in Ease-of-Use

The color DAS 9129, the first logic analyzer with a color-coded CRT, is the undisputed leader in ease-of-use. Each of the instrument's setup menus and data displays are organized into color groups which promote faster interaction, better understanding, reduce chance of error and minimize fatigue.

See the DAS in the Technology Section.

Both the color DAS and its monochrome counterpart have a menu-driven operating system which vastly simplifies all user interactions. Each particular function, such as trigger setup or pattern generation programming, has its own self-explanatory menu. The user simply moves the cursor to the appropriate video fields and supplies the required information. There is no need for lengthy manual references to master the instrument's operation. When a menu entry falls outside acceptable bounds, a message appears which explains the specific nature of the error, thus allowing simple recovery without the need for a separate help function.

### World's Fastest Logic Analyzer

Responding to the need for testing high-speed digital designs, the *NEW* 91HS8 acquisition module provides up to 32 channels at a 2 GHz asynchronous sample rate (500 picosecond sample interval). The 91HS8 combines the time resolution of an oscilloscope with the flexible triggering, glitch detection, memory depth, and channel width of a logic analyzer. In addition, the 91HS8 uses a new generation of high-performance probes with custom ICs in the probe tips. These probes provide a high degree of timing accuracy and signal fidelity.

See page 107 for details on the 91HS8.

For moderately fast systems, the 91A04A/91AE04A acquisition modules deliver sample speeds up to 660 MHz asynchronously or 330 MHz synchronously.

### 8-Bit and 16-Bit Microprocessor Support at its Best

In response to the overwhelming need for good microprocessor support in logic analysis, the DAS 9100 Series offers a greater depth and range of microprocessor-based support than any other analyzer.

The key to this support is the DAS 9100's patented EDM (Extended Define Mnemonics), which allows the built-in DC 100 tape drive to act as a storage medium for mnemonic tables for 8-bit, 16-bit and even custom processors.

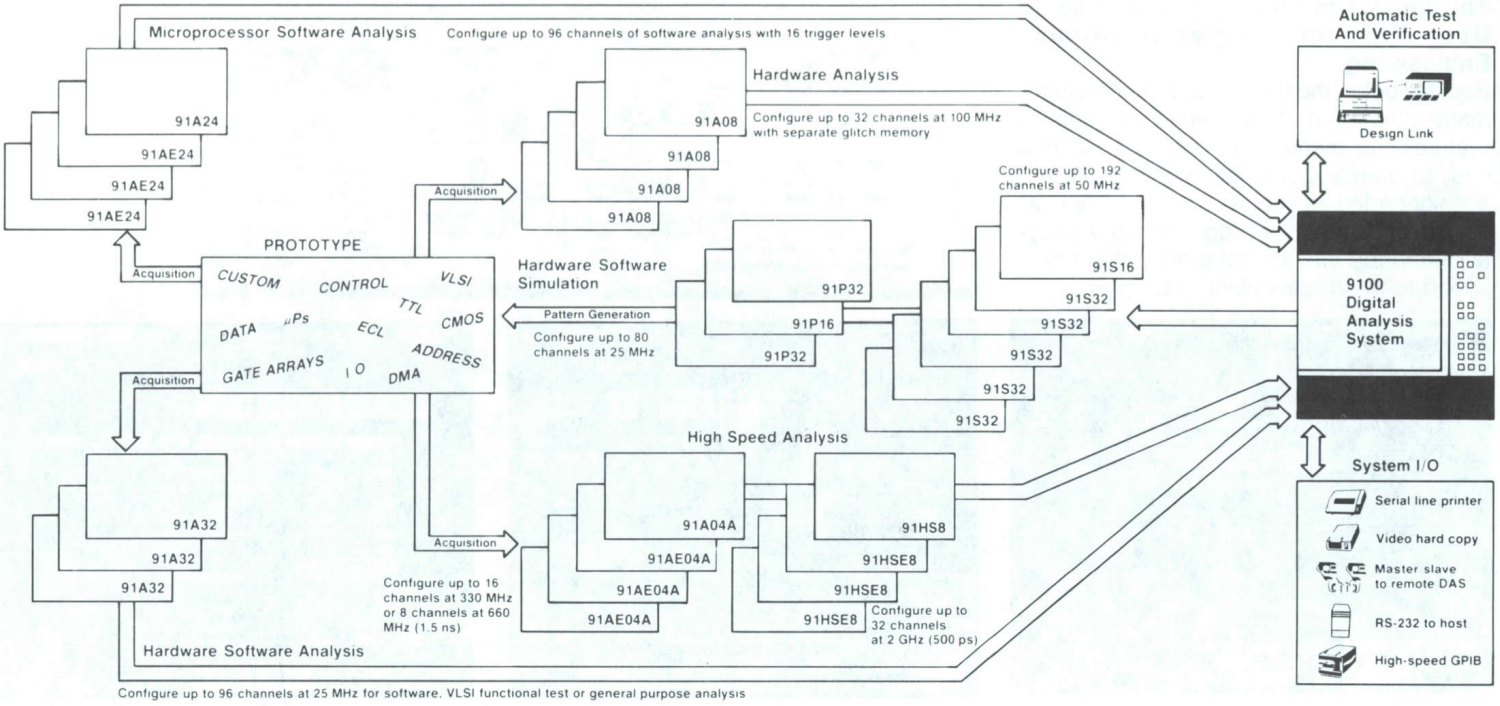
EDM is a powerful, table-driven program which is part of the DAS firmware. All address, data and control information is received by a master table and passed down through a hierarchy of tables which converts it into disassembled mnemonics.

For custom processors, you can use EDM to create your own set of disassembly tables. For commercial processors, Tek offers the following 8-bit and 16-bit EDM tapes.

| | | | |
|---|---|---|---|
| 8080 | 6801 | 68010 | 1805 |
| 8031 | 6802 | Z80 | NSC800 |
| 8039 | 6803 | Z8001 | F9450 |
| 8085 | 6805 | Z8002 | 1750A |
| 8086 | 6808 | Z8003 | UNIBUS |
| 8088 | 6809 | Z8004 | Q-BUS |
| 80186 | 68121 | 6502 | GPIB |
| 80188 | 68000 | 65C02 | ASCII |
| 6800 | 68008 | 1802 | EBCDIC |

Each EDM disassembly tape includes disassembly tables and also a file containing all the setup parameters needed to have the 91A24 data acquisition modules acquire software transactions as executed on the system bus.

*NOTE: For Ordering Information, consult the DAS 9100 Microprocessor Support section on page 123.*




Only the DAS 9100 offers three distinct types of disassembly: Software, Hardware, and Absolute. Software disassembly displays your program flow in the form of an assembly listing. Hardware disassembly displays mnemonics associated with each bus cycle. Absolute disassembly augments the standard State Table display with labels for each bus cycle.

EDM also allows user-selectable color coding of displayed data and the addition of comments and labels. You can even use disassembly mnemonics when defining triggers with the 91A24 trigger menu.

### Select Your Configuration

The DAS 9100 has eight different data acquisition modules and four different pattern generation modules. To obtain the data width and speed your application requires, simply select the appropriate combination of modules and add on later as your needs change. Refer to the performance summary, below, and to the module descriptions on pages 106 through 110.

### Pattern Generation

The DAS 9100 is the first logic analyzer with both acquisition and pattern generation in the same instrument. Pattern generation makes it possible to start debugging hardware before the software, or all of the hardware, is available. You can also use pattern generation to test VLSI devices.

The *NEW* 91S16 and 91S32 modules, at 50 MHz, are the fastest pattern generators available on any logic analyzer. The 91S16 features algorithmic pattern generation, and the 91S32 has stored-pattern generation. These modules can be used separately, combined, or linked with acquisition modules to provide an integrated test system for debugging and verifying digital components, boards, and systems. Widths up to 192 channels are available.

Custom ICs in the 91S16/91S32 probe provide accurate 1 ns edge placement of individual data channels. Also, Tektronix' unique probe-tip technology reliably delivers 50 MHz performance at the device pins.

The 91P16 and 91P32 pattern generator modules feature 25 MHz operation. The 91P16 controller module offers 16 channels of algorithmic pattern generation. With the 91P32 expansion module, you can increase the total to 48 or 80 channels.

### Flexible I/O

The DAS 9100 also offers you powerful I/O options, including a built-in magnetic tape cartridge drive (Option 01) to store instrument setups, pattern sequences, mnemonics and reference memory. The RS-232 and GPIB interface (Option 06) offers complete remote programmability and supports hard copy units, video displays and serial line printers.

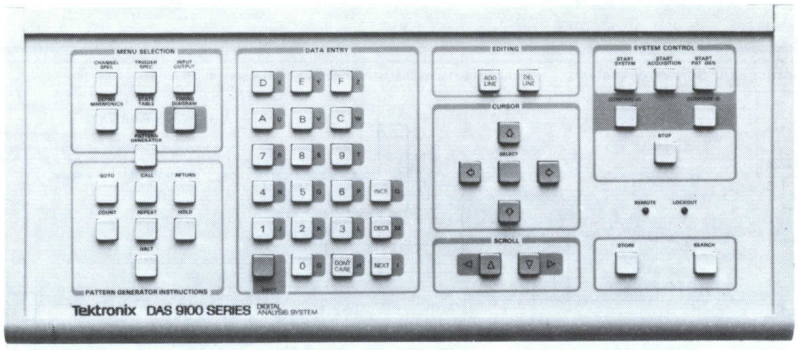
The standard DAS mainframes come with a power supply for two slots. Options 03 and 04 allow you to add one or two additional modular power supplies (each supply powers two slots). You only pay for the capability you need.

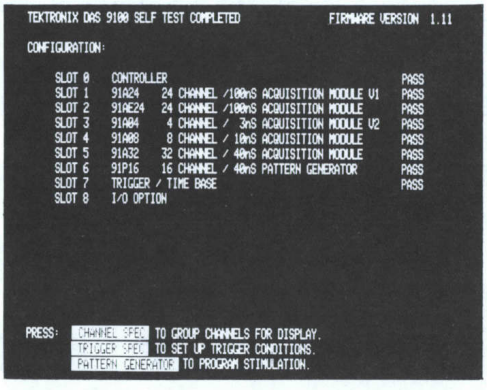
## DAS PERFORMANCE SUMMARY GUIDE

| Module Name | Type | Channels | Maximum Channels | Memory Depth | Speed | Application |
|---|---|---|---|---|---|---|
| ***NEW* 91HS8/91HSE8** | Acquisition | 8 | 32 | 8000 | 2 GHz | Ultra High-Speed Hardware Analysis |
| **91A04A/91AE04A** | Acquisition | 2/4 | 16 | 4096/2048 | 660/330 MHz | High-Speed Hardware Analysis |
| **91A08** | Acquisition | 8 | 32 | 512 | 100 MHz | Hardware Analysis |
| **91A32** | Acquisition | 32 | 96 | 512 | 25 MHz | Hardware/Software Analysis |
| **91A24/91AE24** | Acquisition | 24 | 96 | 1024 | 10 MHz | Sophisticated Software Analysis |
| ***NEW* 91S16** | Pattern Generator (Algorithmic) | 16 | 176 w/ five 91S32 | 1024 | 50 MHz | High-Speed HW/SW Simulation |
| ***NEW* 91S32** | Pattern Generator (Stored-Pattern) | 32 | 192 | 2048 | 50 MHz | High-Speed HW/SW Simulation |
| **91P16/91P32** | Pattern Generator (Algorithmic) | 16/32 | 80 | 254 | 25 MHz | Hardware/Software Simulation |

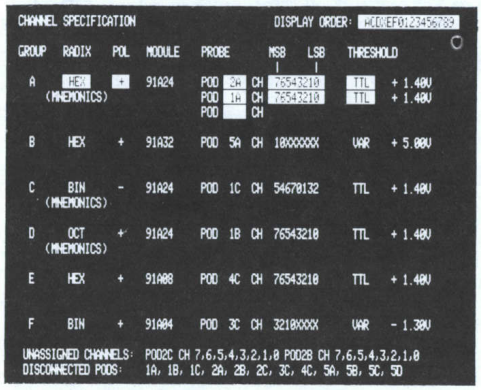
## The Leader in Flexibility and Ease-of-Use Through Superior Human Engineering

Besides color, the DAS 9100 Series includes many other important human engineering features. Its menu-driven user interface is easy to learn and self-documenting. There is a color-coded keyboard organized specifically to enhance user programming. All keys are arranged into logical groups that correspond to the display elements.

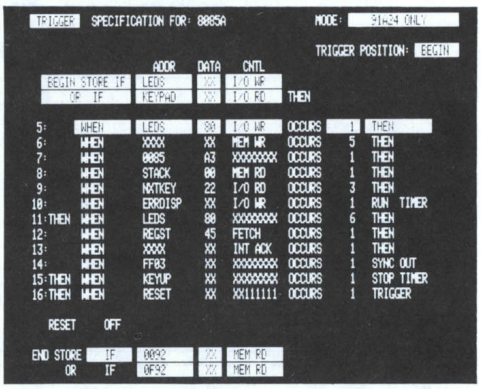


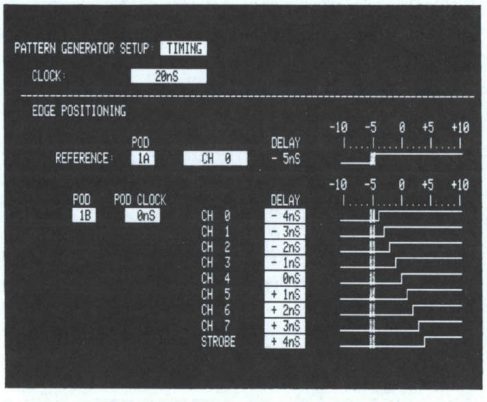

*POWER ON: The configuration menu lists all modules in the DAS by slot location. A self-test verification is performed on each module with pass/fail indication. Bottom of screen indicates next step.*



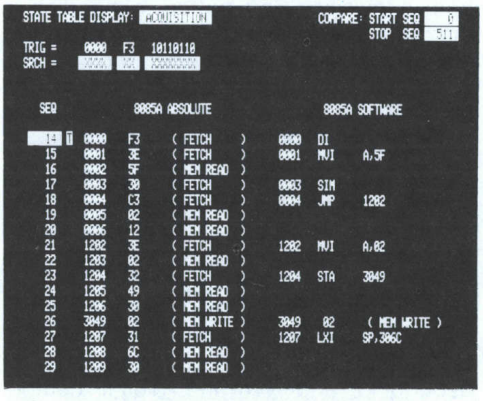

*CHANNEL SPEC: Use CURSOR and DATA ENTRY keys to assign data acquisition channels to groups, select a group radix (hex, bin or oct), and assign probe thresholds and channel order.*



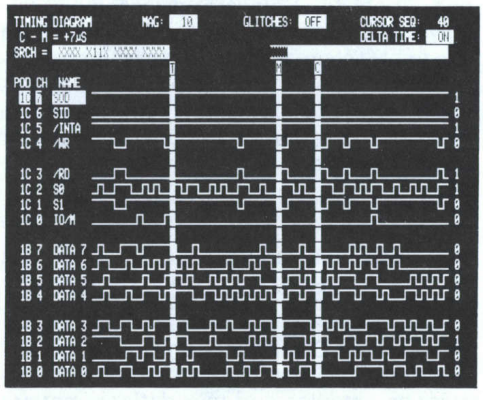

*TRIGGER SPEC: The SELECT key scrolls through all possible triggering combinations including "ARMS MODE". The 91A24's five word recognizers with 16-level stack are shown. Address and control fields display symbolic labels.*



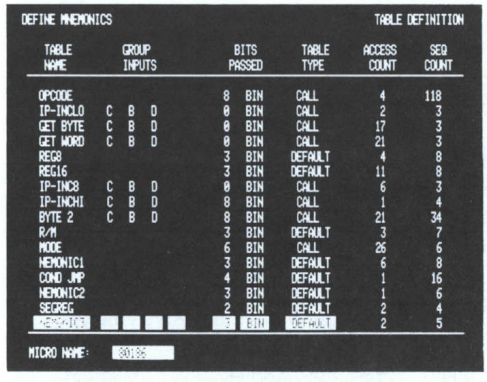

*PATTERN GENERATOR: This Timing menu lets you set up the 91S16/91S32 data channel timing relationships. Each channel may have a different delay. Use the INCR/DECR keys to adjust the delay in 1 ns increments.*



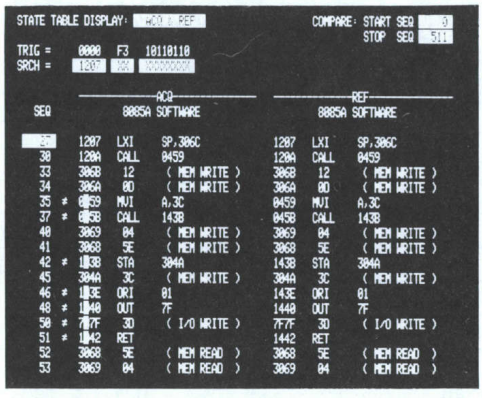

*START SYSTEM: Acquisition occurs, State Table is displayed with trigger word clearly marked. Start acquisition or pattern generator modules with START keys.*



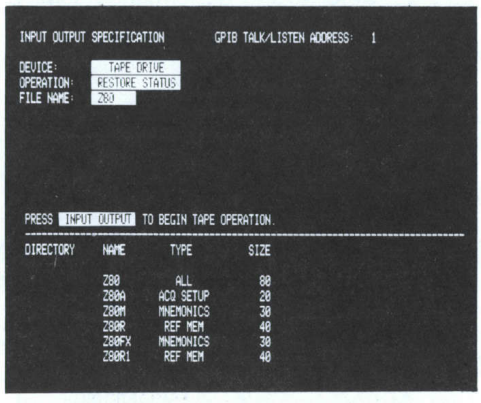

*TIMING DIAGRAM: Displays all acquired data with trigger word clearly indicated. Use SCROLL keys to make DELTA-TIME measurements. Magnify up to X10,000. Add labels for each channel using DATA ENTRY keys.*




*DEFINE MNEMONICS: EDM (Extended Define Mnemonics) provides disassembly for the State Table display. Use it to disassemble any acquired data. EDM is controlled by three menus accessed via the DEFINE MNEMONICS key.*

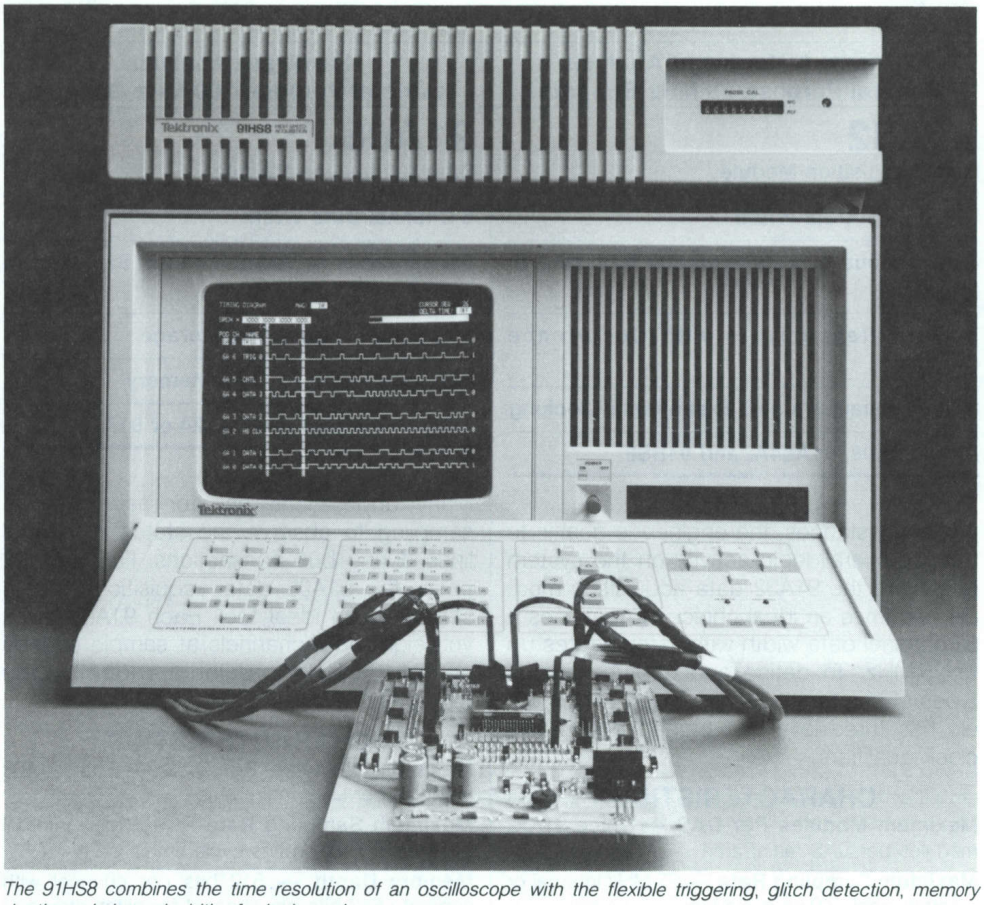



*STATE TABLE: Display ACQ MEM, REF MEM or both. Load REF MEM by pressing STORE. REF MEM may be edited prior to ACQ MEM/REF MEM compare. SEARCH word may be entered and the search started by pressing SEARCH key.*




*INPUT OUTPUT: The I/O menu lets you easily store or retrieve instrument setups, reference patterns and mnemonic files and to define parameters for GPIB, RS-232, Master/Slave, and serial printer operation.*

NEW




*The 91HS8 combines the time resolution of an oscilloscope with the flexible triggering, glitch detection, memory depth, and channel width of a logic analyzer.*

# 91HS8/91HSE8

## 2 GHz Data Acquisition Modules

**2 GHz Asynchronous Sampling Rate (500 Picosecond Sample Interval)**

**8 Data Channels Per Module**

**Expandable to 32 Channels with up to Three 91HSE8s**

**8000 Bits/Channel Memory Depth**

**Durable, Lightweight Probes with Four-Meter Spread, Tip-to-Tip**

**Probe Input Capacitance <1 pF**

**Two Word Recognizers, Plus Timeout and Duration Filter Capability**

**Level and Edge Triggering**

**Glitch Detection and Trigger-on-Glitch Capability**

**Self-Calibration Feature Minimizes Channel-to-Channel Skew**

### World's Fastest Logic Analyzer

The *NEW* 91HS8/91HSE8 acquisition modules provide up to 32 channels at a 2 GHz (500 ps) asynchronous sample rate—the fastest acquisition available on any logic analyzer. The 91HS8/91HSE8 consist of two major components: An interface card that plugs into the DAS 9100 mainframe, and a self-contained acquisition cabinet that sits on top of the DAS. Nine probes are permanently attached to the back panel of the cabinet. These probes provide eight data channels plus an external trigger or arms input.

Channel width may be expanded to 32 channels by adding up to three 91HSE8 expander modules to a 91HS8.

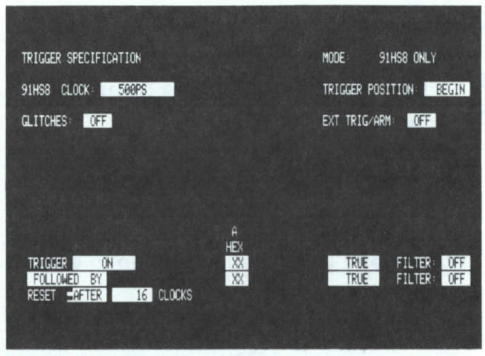
Memory depth is 8000 bits per channel. At slower speeds (≥5 ns sample interval), you can use half of the memory to store glitch information, leaving 4000 bits/channel for data storage.

### Extensive Triggering Capabilities

The 91HS8 provides two word recognizers. Each word recognizer can be programmed to recognize glitches instead of data. A programmable trigger sequencer provides the following selections (where Events A and B are word recognizer values):

Trigger on - Event A
- Event A or Event B
- Event A followed by Event B
- Event A followed by Event B, reset on Timeout
- Event A followed by Timeout, reset on Event B

Both word recognizers can be programmed for edge or level sensitive event recognition. Timer and duration filter parameters permit additional triggering qualification.




*Sample 91HS8 Trigger Menu*

### New Probe Technology Ensures Higher Resolution

The 91HS8 uses a new generation of high-performance probes with custom ICs in the probe tips. These probes provide a high degree of timing accuracy and signal fidelity. They can be placed directly on the circuit under test to minimize timing skews and increase accuracy. Leads sets and grabber tips can also be used.

The low input capacitance of 91HS8 probes (each probe <1 pF) minimizes timing changes in high-speed circuits and reflections in transmission lines.

## CHARACTERISTICS

**Maximum Modules Per DAS** — One 91HS8 max per DAS mainframe, three 91HSE8s max per DAS mainframe. For 16 or more channels, one module must be a 91HS8. For eight channels, use either a 91HS8 or 91HSE8.

**Maximum Number of Inputs** — Eight data channels expanding to 32 with one 91HS8 and three 91HSE8s.

**Maximum Sampling Rate** — 2 GHz internal asynchronous clock, 500 ps sample interval.

**Memory Depth** — 8000 bits/channel. If glitch capture is enabled (clock intervals ≥5 ns), 4000 bits/channel of glitch information and 4016 bits/channel of data.

**Minimum Pulse Width (with 500 ps Clock)** — 1.5 ns.

**Triggering** — Two independent word or glitch recognizers, programmable event timer, edge or level event recognition, event duration filter, trigger reset, external trigger/arm input, trigger positioning in acquisition memory. Armed by 91A32 acquisition module. In multiple-91HS8 configurations, any 91HS8/91HSE8 module can be selected as the trigger source for the other modules.

**Minimum Glitch Width** — 1.5 ns. Glitch detection is available only for sampling intervals ≥5 ns.

**Probes** — 9 per module: 8 data input and 1 external trigger/arm input, permanently attached.

## ORDERING INFORMATION

**91HS8** Data Acquisition Module **$25,000**

**Includes:** Nine permanently-attached probes, nine each probe lead sets; 20 each probe grabber tips; operator manual, probe cable marker clips, clock cables kit, V1.11 to V1.13 firmware upgrade kit.

**91HSE8** Data Acquisition Module **$25,000**

**Includes:** In addition to the above, a trigger cable.

## Software Analysis Microprocessor & Bus Support

# 91A24/91AE24

**Data Acquisition Modules**

- 16 Level Sequential Trigger Tracing
- Data Storage Qualification with up to 4 Word Recognizers
- 32 Bit Counter/Timer with 100 ns Resolution
- 24 Data Channels with 1 k Memory Depth
- 3 External Clocks and 3 Qualifiers with Independently Programmable Expressions
- Single Probe Demultiplexing
- Synchronous or Asynchronous Acquisitions Down to 100 ns Data Cycles
- Supports Over 30 Microprocessors and Buses with 91TMXX Support Series (Page 118)

For software analysis, the 91A24 data acquisition module provides advanced triggering and clocking. It employs five independent word recognizers which include a 16 level stack that lets you build the complex triggers and data qualifiers necessary to debug involved software routines.

### CHARACTERISTICS

**Maximum Modules Per DAS** — One 91A24 (required to operate), three 91AE24s per DAS mainframe.

**Maximum Sampling Rate** — 10 MHz internal or external clock, 100 ns cycle time.

**Memory Depth** — 1023 bits per channel.

**Reference Memory** — 1 k by 48 channels formattable to 512 by 96 channels, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.

**Clock Qualifiers** — Three available on 91A24 only, selectable polarity.

**Clock** — Selectable from one internal or three external sources.
Internal: 100 ns to 5 ms ±01% ±01 ns.
External: Three clock inputs, 20 MHz maximum, selectable rising or falling edge. Demultiplex mode with 50 ns DEMUX interval minimum and 100 ns cycle minimum.

**Triggering** — Five independent word recognizers with selectable operating modes.

**Trigger Arming** — Arms 91A08 or 91A04A.

**Event Counter** — Counts from 1 to 4,096 events programmed on individual stack levels.

**Probes** — P6460 or P6462, three per module; mixing probes is not recommended.

**Data Set Up Time** — 25 ns minimum using P6460, 29 ns minimum using P6462.

**Data Hold Time** — 0 ns maximum using P6460, 3 ns maximum using P6462.

## Software & Hardware Analysis General Purpose 25 MHz Support

# 91A32

**Data Acquisition Module**

- 32 Channel Data Width
- Synchronous or Asynchronous Sampling to 25 MHz
- 3 Word Recognizers with Occurrence Counter
- 2 Clock Qualifiers and Expandable Clocking
- Arms 91A08, 91A04A, and 91HS8

In many instances, the engineer's goal is to monitor overall logic activity on the system bus. Here the 91A32 data acquisition module becomes an ideal choice. It combines a 32-channel data width with sample rates up to 25 MHz. To define and capture various types of bus transactions, each 91A32 module has three levels of triggering and two clock qualifiers.

### CHARACTERISTICS

**Maximum Modules Per DAS** — Three 91A32 modules per DAS mainframe.

**Maximum Sampling Rate** — 25 MHz internal or external clock, 40 ns cycle time.

**Memory Depth** — 512 bits per channel.

**Reference Memory** — 512 bits/channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.

**Clock Qualifiers** — Two per module, six maximum, selectable polarity.

**Clock** — Selectable from one internal or up to three external sources.
Internal: 40 ns to 5 ms ±01% ±01 ns.
External: Selectable rising or falling edge, demultiplex split clock mode available with two or three 91A32 modules.

**Triggering** — Three word recognizers, two provide sequential or independent triggering with occurrence counter, one provides independent reset function. External trigger enable input and word recognizer output.

**Trigger Arming** — Arms 91A08, 91A04A, or 91HS8.

**Event Counter** — Counts from 1 to 32,767 word recognizer events.

**Probes** — P6452 or P6462, four per module; mixing probes is not recommended.

**Data Setup Time** — 29 ns minimum using P6452, 25 ns minimum using P6462.

**Data Hold Time** — 0 ns maximum using P6452, 7 ns maximum using P6462.

## Hardware Analysis General Purpose 100 MHz Support

# 91A08

**Data Acquisition Module**

- 8 Channel Data Width
- Synchronous or Asynchronous Sampling to 100 MHz
- 5 ns Glitch Trigger and Storage
- Separate Glitch Storage Memory
- Trigger Arming From 91A24 or 91A32

Many applications call for asynchronous sampling to observe the status of control lines during bus transactions. For this purpose, the 91A08 data acquisition module serves as an ideal tool. Each 91A08 gives you eight data channels at sample speeds up to 100 MHz and independent glitch triggering.

### CHARACTERISTICS

**Maximum Modules Per DAS** — Four 91A08 modules per DAS mainframe.

**Maximum Sampling Rate** — 100 MHz internal or external clock, 10 ns cycle time.

**Memory Depth** — 512 bits per channel with separate 512 bits per channel for glitch storage.

**Reference Memory** — 512 bits per channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.

**Clock Qualifier** — One per module, four maximum, selectable polarity.

**Clock** — Selectable from two internal or two external sources.
Internal: 10 ns to 50 ms ±01% ±01 ns.
External: Selectable rising or falling edge.

**Triggering** — Single level word recognizer and glitch recognizer. External trigger enable using arms mode.

**Trigger Arming** — Armed by 91A24 or 91A32.

**Probes** — P6452, one per module.

**Data Setup Time** — ≤9 ns using one 91A08, ≤10 ns using multiple 91A08 modules.

**Data Hold Time** — 0 ns maximum.

**Glitch Storage** — 5 ns minimum glitch width.

## Hardware Analysis 660 MHz or 330 MHz Support

# 91A04A/91AE04A

**Data Acquisition Module**

- Asynchronous Acquisition to 660 MHz on 2 Channels (1.5 ns Sample Interval)
- Asynchronous Acquisition to 330 MHz on all 4 Channels (3.0 ns Sample Interval)
- Synchronous Aquisition to 330 MHz
- 2048 Bits Per Channel in 4-Channel Mode 4096 Bits Per Channel in 2-Channel Mode
- Trigger Arming From 91A24 or 91A32
- Auto-Deskewing Minimizes Channel-to-Channel Skew and Ensures Optimum Setup and Hold Times

This 91A04A 660 MHz asynchronous sample rate gives you a timing resolution of 1.5 ns, fast enough to actually capture and display glitches in their true timing relationship to other signals. Now you can truly analyze where those errant pulses originated.

### CHARACTERISTICS

**Maximum Modules Per DAS** — One 91A04A, three 91AE04As per DAS mainframe (requires 91A04A to operate).

**Maximum Number of Inputs** — Four data channels expandable to 16 channels with one 91A04A and three 91AE04A modules.

**Maximum Sampling Rate** — 660 MHz internal two channels only (1.5 ns sample interval), 330 MHz internal clock four channels (3 ns cycle time), 330 MHz external clock four channels (3.3 ns cycle time).

**Memory Depth** — 2048 bits per channel; 4096 bits per channel in two channel 1.5 ns mode only.

**Reference Memory** — 512 bits per channel, compare with acquisition, trigger on compare equal or not equal, column masking and programmable compare window.

**Clock** — Selectable from one internal or one external source. No qualifiers.
Internal: 1.5 ns to 5 ms.
External: Selectable rising or falling edge.

**Triggering** — Single level word recognizer. (In 1.5 ns mode only trigger word must be valid for one sample period +2.5 ns). External trigger enable using arms mode.

**Trigger Arming** — Armed by 91A24 or 91A32.

**Probe** — P6453, one per module included.

**Data Setup Time** — 3.0 ns worst case adjustable in 400 ps increments.

**Data Hold Time** — 0.3 ns worst case adjustable in 400 ps increments.

**Channel to Channel Skew** — 0.50 ns on rising edges typical, 0.90 ns on falling edges typical.

**Minimum Detectable Pulse Width** — 3.5 ns worst case.

## Pattern Generation 25 MHz Stimulus Support

# 91P16/91P32

**Pattern Generator Modules**

- Stimulus Data and Clock Rates to 25 MHz
- Data Widths of 16, 48 or 80 Output Channels
- Up to 10 Independently Programmable Strobes
- Programmable Tri-State Output Control
- External Pause, Tri-State, and Interrupt Control Inputs
- Vector Count, Hold, Repeat, and Looping Operations
- Vector Sub Routine, Nested up to 16 Levels

### CHARACTERISTICS

**Maximum Modules Per DAS** — One 91P16, two 91P32s per DAS mainframe (requires 91P16 to operate).

**Maximum Number of Outputs** — Expandable to 80 data channels and 10 strobes with one 91P16 and two 91P32s.

**Number of Strobes** — Two strobe outputs on 91P16, four strobe outputs on 91P32.

**Maximum Stimulus Rate** — 25 MHz internal or external clock, 40 ns cycle time.

**Pattern Memory Depth** — 254 words or instructions, able to output over 65,000 unique patterns single pass or continuous.

**External Control Lines** — Pause: Hold pattern output temporarily while asserted, selectable polarity. Inhibit: Tri-states all outputs while asserted, selectable polarity. Interrupt: Forces jump to subroutine after asserted, selectable rising or falling edge.

**Clock** — Selectable from one internal or one external source and single step operation. One clock line per probe, rising edge signifies beginning of cycle.
Internal: 40 ns to 5 ms ±01% ±01 ns.
External: Selectable rising or falling edge.

**Instruction Set** — COUNT (n): Increment pattern n times, one per clock. HOLD (n): Hold pattern output and clock for n cycles. REPEAT (n): Hold pattern output for n cycles. GOTO (Label): Output patterns starting at label. CALL (Label): Call subroutine at label. RETURN: Return from subroutine. HALT: Halt pattern and clock.

**Nested Subroutines** — 16 maximum.

**Strobe Pulse Polarity** — Selectable positive or negative.

**Strobe Delay Time** — Selectable from 70 ns to 40.910 μs in 40 ns steps.

**Strobe Pulse Width** — Selectable from 40 ns to 40.880 μs in 40 ns steps.

**Probes** — P6455 for TTL/MOS, P6456 for ECL, or P6457 for TTL/MOS with individual bit Tri-State. Two per 91P16 module, four per 91P32 module.

**Output Data Skew** — ≤10 ns.

**Output Clock Skew** — ±5 ns between probes.

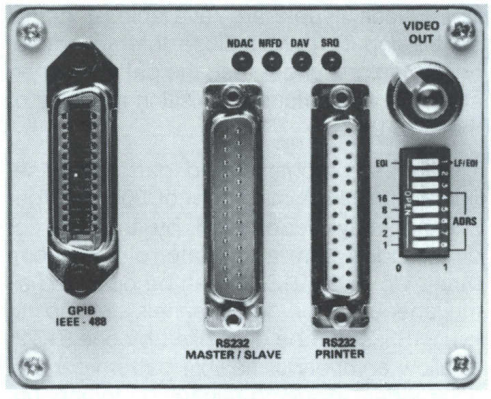
## GPIB, RS-232, Tape Drive, Line Printer & Hard Copy Support

# Options 01/06

**Communication Interface Options**

- High Speed GPIB (200 kbytes/second)
- RS-232 Host Interface
- RS-232 Line Printer Port
- RS-232 Master/Slave Operation
- Video Out/Hard Copy Support
- DC 100 Tape Drive Local Storage

The DAS Option 06 external communications package provides a complete array of I/O capabilities to handle both computer and peripheral interfaces. It includes GPIB, RS-232 master/slave, RS-232 printer port and hard copy interfaces. In the GPIB mode, a host controller supplies all DAS menu setups and receives test results, with the DAS serving either as talker or listener. In the master/slave mode, one DAS acts as the master controller for a second DAS, which may be in a remote location and linked to the master DAS via modem. For stand-alone DAS installations, the RS-232 printer port and hard copy (video) output provide excellent documentation support.




*Rear Communications Interface panel Option 06*

DAS 91DVV VLSI Verification Software uses the host communications capability of Option 06 to transfer test vector patterns to the DAS and to upload actual VLSI functional test data for host analysis.

The Option 01 built-in DC 100 tape drive provides convenient, menu-operated local storage and retrieval. It accepts tape cartridges (each holding up to 32 separate files) to store reference data, pattern generation programs, mnemonics tables, or data acquisition setups.

# 91S16/91S32

## 50 MHz Pattern Generation Modules

**Clocking Rates to 50 MHz (20 ns Cycle Time)**

**Up to 192 Programmable Data Output Channels**

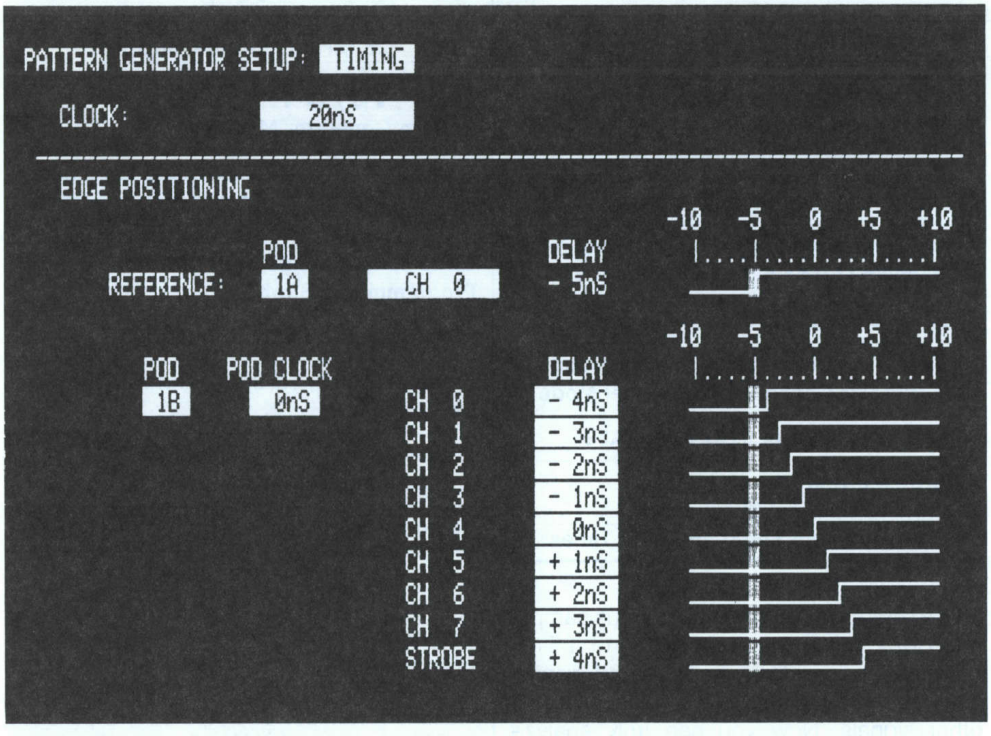
**1 ns Edge Positioning**

**External Control Inputs**

**Algorithmic and Stored-Pattern Output Control**

**Tri-State Outputs and Control**

**Simplified Programming from DAS Keyboard**

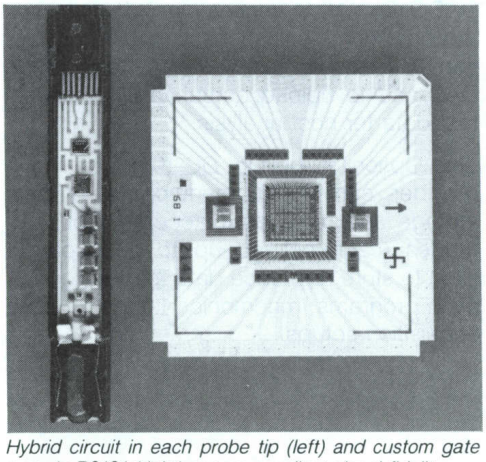



*The 91S16/91S32 Timing menu lets you adjust the timing relationships between output clocks, data channels, and strobes in 1 ns increments.*

The *NEW* 91S16/91S32 modules, at 50 MHz, are the fastest pattern generators available on any logic analyzer. The 91S16 features algorithmic pattern generation, and the 91S32 has stored-pattern generation. These modules can be used separately, combined, or linked with acquisition modules to provide an integrated test system for debugging and verifying digital components, boards, and systems.

The 91S16 is an algorithmic pattern generator. It outputs vectors as a result of executing a user-written pattern generator program of up to 1024 instructions. Nine instructions types are available. External control inputs permit close interaction between the unit under test, the pattern generator, and the various acquisition modules of the DAS 9100.

The 91S32 outputs stored patterns in sequential order. A maximum of 2048 bits per channel may be entered by the user or downloaded from a simulator or host computer. Up to six 91S32s can be operated simultaneously for 192 channels, or up to five 91S32s can be controlled by one 91S16 to allow a variety of flexible pattern-generation modes, including reloading memory on-the-fly.



*Hybrid circuit in each probe tip (left) and custom gate array in P6464 (right) ensure excellent signal fidelity.*

### High-Quality Probing Technology

The 91S16/91S32 both use the *NEW* P6464 Pattern Generator Probe. A custom gate array in the P6464 and hybrid circuits in each probe tip provide accurate 1 ns edge placement of output signals and reliably deliver 50 MHz performance at the pins of the device under test. This performance makes the 91S16/91S32 the most precise pattern generators ever offered on a logic analyzer. The P6464 supports both TTL and ECL circuitry.

## CHARACTERISTICS

**Maximum Modules Per DAS —** One 91S16 max per DAS mainframe. Six 91S32 modules max per DAS mainframe. When used with 91S16, max five 91S32 modules per DAS.

**Maximum Number of Outputs —** 91S16: 16 data channels, two clocks, two strobes; expandable to 176 data channels, 22 clocks, 22 strobes when combined with five 91S32s. 91S32: 32 data channels, four clocks, four probes, expandable to 192 channels, 24 clocks, 24 strobes with six 91S32s. If strobes are used as data channels, six 91S32s provide 216 channels, and one 91S16 and five 91S32s provide 198 channels.

**Maximum Stimulus Rate —** 91S16: 50 MHz internal or external clock (20 ns cycle time). 91S32: 50 MHz internal clock, 25 MHz external clock (40 ns cycle time).

**Pattern Memory Depth —** 91S16: 1024 patterns or instructions. 91S32: 2048 patterns.

**External Controls —** 91S16 Inputs (Using Optional P6460 External Control Probe): External Clock, Pause, Inhibit (tri-state), Jump, Interrupt, Interrupt Qualify. 91S16 External Start input uses optional phono connector. 91S16 Output: Trigger Out. 91S32 Inputs (using P6452 External Clock Probe): External Clock, Inhibit, External Start, and Pause.

**Master Clock —** Selectable from one internal or one external source and single-step operation. Internal: 20 ns to 5 ms. External: Selectable rising or falling edge.

**Clock Output —** One clock line per probe. Rising edge may be adjusted ±5 ns relative to selected edge (rising or falling) of master clock.

**Data and Strobe Output —** Eight data channels and one strobe per probe. Individual channels can be adjusted ±10 ns relative to the master clock (up to ±5 ns relative to the output clock for that probe). Timing adjustments can be made in 1 ns increments.

## ACCESSORIES

**91S16 Standard:** Two P6464 pattern generator probes; keyboard overlay (334-6094-00); "External Control Probe" label for optional P6460 probe (334-6230-00); operator manual (070-5396-00); operator reference guide (070-5398-00).

**91S16 Optional:** P6460 external control probe; controlled-width probelet (020-1392-00); 2 m trigger out cable (175-8165-00); external start cable, 9 inch (175-9676-00); delay line adjustment tool (003-1134-00); service manual (070-5397-00).

**91S32 Standard:** Four P6464 pattern generator probes; interconnect cable (175-9700-00); keyboard overlay (334-6094-00); operator manual (070-5396-00); operator reference guide (070-5398-00).

**91S32 Optional:** Delay line adjustment tool (003-1134-00); controlled-width probelet (020-1392-00); extender interconnect cable (175-9782-00); service manual (070-5397-00).

## ORDERING INFORMATION

**See Ordering Information on page 112.**

**Select the Performance and Price That Meets Your Application Need.**
The DAS 9100 is a modular architecture system designed to keep you state-of-the-art as your application needs change and grow. The modular DAS 9100 mainframe accepts up to six modules chosen from the selection of Data Acquisition and Pattern Generation modules listed on pages 107 through 110.

The standard DAS 9100 mainframes with their associated options are shown on page 112. These DAS 9100 mainframes come standard with two module slots already powered. Options 03 and 04 allow you to add one or two power supplies, with each power supply providing power for two additional module slots. You only pay for the capability you need.

The Standard Configurations shown below provide an easy way to order a DAS already configured for your application. Use the chart below to match your application with the appropriate standard configuration.

**Microprocessor Support.**
The widest selection of microprocessor support packages in the industry is listed on page 123.



## DAS 9100 STANDARD CONFIGURATIONS ORDERING GUIDE

| Standard Configuration Model Number | | Recommended Application | Acquisition Modules | Pattern Generation Modules | Options Included | Performance Features |
|---|---|---|---|---|---|---|
| Color Display | Monochrome Display | | | | | |
| **DAS 9121 $16,370** | **DAS 9101 $13,470** | General Purpose Hardware Analysis | Two 91A08 | | | 16 Channel 100 MHz Data Acquisition |
| **DAS 9122 $17,380** | **DAS 9102 $14,480** | General Purpose Acquisition With Stimulus | One 91A32 | One 91P16 | | 32 Channel 25 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation |
| **DAS 9123 $22,165** | **DAS 9103 $19,265** | General Purpose Software/Hardware Integration | One 91A32<br>One 91A08 | One 91P16 | Opt 03 Power | 32 Channel 25 MHz Data Acquisition<br>8 Channel 100 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation |
| **DAS 9124 $33,390** | **DAS 9104 $30,490** | Expanded Software/Hardware Integration | Two 91A32<br>Two 91A08 | One 91P16 | Opt 01 Tape<br>Opt 04 Power | 64 Channel 25 MHz Data Acquisition<br>16 Channel 100 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation<br>DC 100 Tape Mass Storage |
| **DAS 9125 $19,540** | **DAS 9105 $16,640** | General Purpose Microprocessor Support | One 91A24<br>One 91AE24 | | Opt 01 Tape | 48 Channel 10 MHz Data Acquisition<br>DC 100 Tape Mass Storage |
| **DAS 9126 $24,550** | **DAS 9106 $21,650** | High Speed Hardware Analysis | One 91A04A<br>One 91AE04A | | Opt 01 Tape<br>Opt 03 Power | 4 Channel 660 MHz or<br>8 Channel 330 MHz Data Acquisition<br>DC 100 Tape Mass Storage |
| **DAS 9127 $28,315** | **DAS 9107 $25,415** | Microprocessor Software/Hardware Integration | One 91A24<br>One 91AE24<br>One 91A08 | One 91P16 | Opt 01 Tape<br>Opt 03 Power | 48 Channel 10 MHz Data Acquisition<br>8 Channel 100 MHz Data Acquisition<br>16 Channel 25 MHz Pattern Generation<br>DC 100 Tape Mass Storage |
| **DAS 9128 $45,760** | **DAS 9108 $42,860** | Interactive ATE: VLSI Verification | Three 91A32 | One 91P16<br>Two 91P32 | Opt 01 Tape<br>Opt 04 Power<br>Opt 06 Comm | 96 Channel 25 MHz Data Acquisition<br>80 Channel 25 MHz Pattern Generation<br>DC 100 Tape Mass Storage<br>GPIB/RS-232 Communications Interface<br>Serial Line Printer Port<br>Display Video Output |
| **DAS 9130 $108,000** | | Ultra High-Speed Hardware Analysis | One 91HS8<br>Three 91HSE8 | | Opt 01 Tape<br>Opt 03 Power<br>Opt 06 Comm | 32 Channel 2 GHz Data Acquisition<br>DC 100 Tape Mass Storage<br>GPIB/RS-232 Communications Interface<br>Serial Line Printer Port<br>Display Video Out |
| **DAS 9118 $40,710** with DAS 9119 ATE mainframe | | Remote Only Operation; Display and Keyboard Not Included | Three 91A32 | One 91P16<br>Two 91P32 | Opt 04 Power<br>Opt 06 Comm | 96 Channel 25 MHz Data Acquisiton<br>80 Channel 25 MHz Pattern Generation<br>CRT and Keyboard Deleted<br>GPIB/RS-232 Communications Interface<br>Serial Line Printer Port<br>Display Video Output |

## DAS 9100 CHARACTERISTICS

### DATA FORMATTING

**Group Designations** — Up to 16 groups (1 to 32 channels per group).

**Radix** — Octal, Binary, or Hexadecimal.

**Polarity** — Positive or negative (complement).

**Threshold** — Select TTL or variable.

### TRIGGERING

**Trigger** — Synchronous or Asynchronous.

**Trigger Word Position** — Begin, Center, End of Memory, or Delay 1 to 32,767 clocks.

**Trigger Word Display** — Hex, Binary, Octal, or mixed radix; any bits allowed as don't care (X).

**Trigger Modes (Word Recognition)**
Up to five word recognizers with sixteen level stack (module dependent, see individual acquisition module specs)
- External Trigger Enable (TTL)
- Word Recognizer Output (TTL)
- 91A32 arms 91A08, 91A04A, or 91HS8
- 91A24 arms 91A08 or 91A04A
- 91A32 and 91A08
- Compare until equal or not equal

**Glitch Recognizer (91A08 and 91HS8)**
- Enable by channel
- 91A08: OR'ed with trigger word
- 91HS8: Either word recognizer can be data or glitch

**Clocks and Qualifiers** — See individual module specs.

### DATA ACQUISITION DISPLAY MODES

**Timing Diagram Features**
- 16 user-selectable channels
- User definable six-character trace labels for each displayed channel
- Data magnification factors from X1 to X10,000
- Cursor position and word readout in binary
- Search word
- Time aligned display for arming mode
- Glitch display select (91A08 and 91HS8)
- Horizontal data scrolling
- Memory display window
- Delta time measurement cursors

**State Table Features**
- Hex, Binary, Octal, or mixed radix
- Search word
- Time-aligned display for arms mode
- Vertical or block scrolling
- Up to 1023 bits by 96 channels reference memory display, with or without data acquisition display
- Reference memory editing
- Programmable compare window
- Reference memory mask word capability
- Compare mode—highlighted and flagged for differences

### I/O SUMMARY

**DC 100 Tape Drive (Option 01)**
Stores six instrument setups or 20 reference memory patterns. Directory space for 32 files.

**RS-232 (Option 06)**
Selectable rates to 9600 baud.
Master/Slave Operation: Full Duplex, Asynchronous

**GPIB (Option 06)**
Talker/Listener Only. Selectable Address.
Selectable Controller Type, EOI or LF/EOI.

**Line Printer Output (Option 06)**
RS-232 serial printers supported.
Selectable baud rates to 9600 baud.
Supports CTRL/S and CTRL/Q handshaking (X-on/X-off).

**Composite Video Output (Option 06)**
Hardcopy interface. Video monitor interface.

### OTHER CHARACTERISTICS

**LO Line** — 90 V to 132 V RMS.

**HI Line** — 180 V to 264 V RMS.

**Line Frequency** — 48 Hz to 63 Hz.

**Power** — 1000 VA, maximum.

**Temperature Range** — Operating: 0°C to +50°C (+32°F to +122°F). Nonoperating: −40°C to +65°C (−40°F to +149°F).

**Altitude** — Operating: 10,000 ft maximum. Nonoperating: 50,000 ft. maximum.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 432 | 17.0 |
| Height | 241 | 9.5 |
| Depth | 597 | 23.5 |
| **Weight** | **kg** | **lb** |
| Without Accessories | 21.8 | 48.0 |

## ORDERING INFORMATION*1

### MAINFRAME ONLY

**DAS 9109** Monochrome Mainframe **$5,500**
**Includes:** P6452 probe; P6454 external clock probe; ejector tool (214-3154-00); operators manual (062-5847-09); seminar workbook (062-7596-00).

**DAS 9119** ATE Mainframe (Deletes CRT and Keyboard; Adds Option 06) **$6,350**
**Includes:** Same as above.

**DAS 9129** Color Mainframe **$8,400**
**Includes:** Same as above.

### MAINFRAME OPTIONS

**Option 01** — DC 100 Tape Drive. **+$1,450**

**Option 03** — One Additional Power Supply. **+$800**

**Option 04** — Two Additional Power Supplies. **+$1,600**

**Option 05** — Rackmount Hardware. **+$200**

**Option 06** — GPIB, RS232, Line Printer Port. **+$1,550**

**Option 88** — Mainframe shipped with modules installed and checked out as part of the mainframe. **NC**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16 A, 50 Hz.
**Option A2** — UK, 240 V/13 A, 50 Hz.
**Option A3** — Australian, 240 V/10 A, 50 Hz.
**Option A4** — North American, 240 V/15 A, 60 Hz.
**Option A5** — Switzerland, 220 V/10 A, 50 Hz.

### MAINFRAME FIELD INSTALLABLE OPTIONS

**DAS 91F1** — Field Installed Option 01 (Includes Installation in Service Center). **$1,700**

**DAS 91F3** — Field Installed Additional Power Supply. **$800**

**DAS 91F6** — Field Installed Option 06 (For Mainframes Above S/N B020100). **$1,700**

*1 *The DAS is also available in several models conveniently preconfigured with mainframe, options, and modules for your application. See page 110.*

### MAINFRAME MODULES

The following modules include probes. See probe selection guide at end of this order section for more information. Maximum of six modules per mainframe, 104 data acquisition channels, 80 pattern generator channels when using 91P16/91P32, or 192 pattern generator channels when using 91S16/91S32.

**91AE04A** — Data Acquisition. **$5,950**
**91AE24** — Data Acquisition. **$4,700**
**91A04A** — Data Acquisition. **$7,950**
**91A08** — Data Acquisition. **$3,985**
**91A24** — Data Acquisition. **$4,990**
**91A32** — Data Acquisition. **$4,990**
**91HS8** — Data Acquisition. **$25,000**
**91HSE8** — Data Acquisition. **$25,000**
**91P16** — Pattern Generator. **$3,990**
**91P32** — Pattern Generator. **$6,900**
**91S16** — Pattern Generator. **$6,900**
**91S32** — Pattern Generator. **$10,400**

*Note: When adding modules, check that the correct number of power supplies are also selected. The mainframe includes sufficient power for two modules. One additional power supply (Option 03) is required for three or four modules. Two additional power supplies (Option 04) are required for a total of five or six modules.*

*Microprocessor/Bus support: For ordering information please see page 120.*

### PROBES

**P6452** — 8-Channel Data Acquisition Probe. **$730**
**P6453** — 4-Channel Data Acquisition Probe. **$1,560**
**P6454** — External Clock Probe For 91A08 Modules. (Only one required, included with each DAS 9100 Mainframe.) **$265**
**P6455** — 8-Channel TTL/MOS Pattern Generator Probe. **$575**
**P6456** — 8-Channel ECL Pattern Generator Probe. **$575**
**P6457** — 4-Channel Tri-State Pattern Generator Probe. **$575**
**P6460** — 8-Channel Data Acquisition Probe. **$700**
**P6462** — 8-Channel TTL Only Data Acquisition Probe. **$340**
**P6464** — 8-Channel TTL/ECL Pattern Generator Probe. **$1,350**

### PROBE SELECTION GUIDE

| DAS Module | No. Probes Required | Included As Standard | Optionally Available |
|---|---|---|---|
| 91A04A | 1 | P6453 | |
| 91AE04A | 1 | P6453 | |
| 91A08 | 1 | P6452 | |
| 91A24 | 3 | P6460 | P6462 |
| 91AE24 | 3 | P6460 | P6462 |
| 91A32 | 4 | P6452 | P6462 |
| 91HS8 | 9 | Probes permanently attached | |
| 91HSE8 | 9 | Probes permanently attached | |
| 91P16 | 2 | P6455 | P6456, P6457 |
| 91P32 | 4 | P6455 | P6456, P6457 |
| 91S16 | 2 | P6464 | |
| 91S32 | 4 | P6464 | |

For optional accessories please see pages 128 through 131.

# 91DVV DesignLink DAS VLSI Verification Software Package

**Links DAS 9100 to Host for Bench-Top VLSI and Circuit Board Testing**

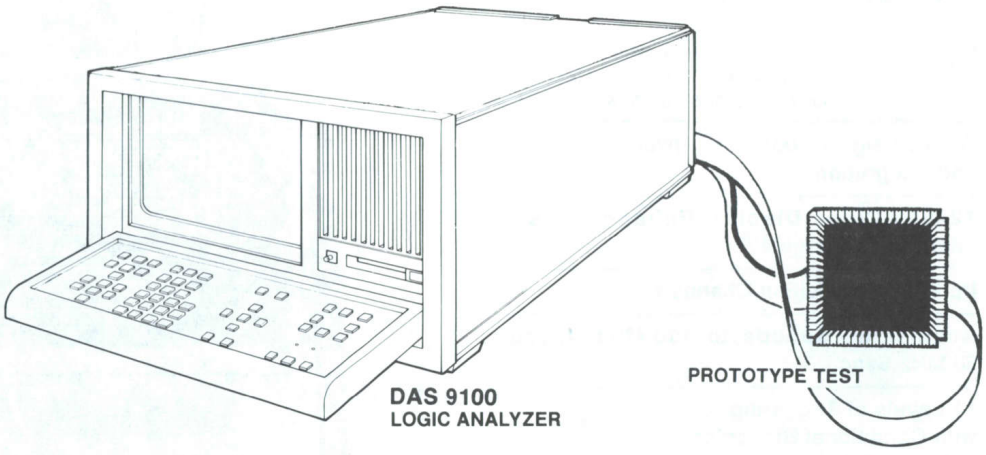
**Uses Logic-Simulation Test Vectors for Prototype Test**

**Vector Compression Increases Effective DAS Pattern Generator Depth**

**Compares Predicted Outcomes to Actual Prototype Responses**

**Rapid Setup Changes for Different Users and Prototypes**

**Modular Software is Easily Installed and Portable**




The 91DVV DesignLink DAS VLSI Verification Software provides communications capabilities between a host and the DAS 9100 Logic Analyzer for bench-top VLSI and circuit board testing applications. 91DVV is an easily set up and low-cost alternative to production test systems.

91DVV remotely controls pattern generation, data acquisition, and comparison between predicted and actual device responses. The 91DVV software converts test-vector tables into compressed DAS pattern generator programs, which it then downloads to the DAS for stimulation of the device. The prototype's resulting outputs are acquired by the DAS and uploaded to the host, where 91DVV compares the actual to predicted responses.

### Easy to Use

The 91DVV software package is straightforward to use. Hardware setup consists of connecting DAS pattern generator and data acquisition probes to a powered test fixture, which holds the prototype device. The 91DVV software automatically queries the DAS to determine the current DAS hardware configuration, and uses the information to set up the prototype test and comparison. A prompting dialogue helps you set up clocking, tri-state control, and vector-to-pin mapping.

### Modular Structure

91DVV software is composed of several modules (refer to the diagram above). TLOGS2PAT: Converts the output of the proprietary Tektronix TLOGS logic simulator into an easily processed intermediate format. For pattern conversion from other logic simulators, the user must create another conversion program. A sample program and a complete description of the intermediate format are supplied. DASXFER: Converts the intermediate vector file into a form the DAS can use in its specific configuration. DASPAC: Compresses the DASXFER output and compiles it into DAS binary packets. PUTPAC: Downloads DAS binary packets from the host environment to the DAS. GETACQ: Uploads contents of the DAS acquisition memory (up to 104 channels) to the host. CMPACQ: Compares predicted device responses to the outputs acquired by the DAS.

### Tri-State Support

The 91DVV software supports use of P6457 tri-state pattern generator probes, and also supports two methods for controlling customer-supplied tri-state buffers.

### Operating Environment

91DVV1P—Runs on the IBM PC and PC/XT. Requires the IBM PC-DOS operating system, version 2.0 or above.

91DVV1G/H—Runs on DEC VAX 11/700 Series mainframes. Requires the UNIX 4.1bsd operating system.

91DVV1K/L—Runs on DEC VAX 11/700 Series mainframes. Requires the VMS operating system, version 3.4 or above.

91DVV is customer installed.

Source code is provided with all versions of 91DVV for customer extension and local modification.

### Compatibility

91DVV is compatible with all DAS mainframes. All DAS keyboard and menu functions remain operable when used with 91DVV. DAS modules supported are: 91A32 and 91A08 data acquisition modules; 91P16 and 91P32 pattern generator modules. DAS probes supported are: P6452 and P6454 data acquisition probes; P6455, P6456, and P6457 pattern generator probes. 91DVV supports DAS Option 06 I/O communications options through the RS-232 link.

## ORDERING INFORMATION

| | |
|---|---|
| **91DVV1G** DAS DesignLink Software Package for DEC VAX UNIX 4.1bsd, 9-Track, 1/2 inch tape, 800 bpi density, retention or use license supplied | **$1,000** |
| **91DVV1H** DAS DesignLink Software Package for DEC VAX UNIX 4.1bsd, 9-track, 1/2 inch tape, 1600 bpi density, retention or use license supplied | **$1,000** |
| **91DVV1K** DAS DesignLink Software Package for DEC VAX VMS 3.4+, 9-track, 1/2 inch tape, 1600 bpi density, retention or use license supplied | **$1,000** |
| **91DVV1L** DAS DesignLink Software Package for DEC VAX VMS 3.4+, 9-track, 1/2 inch tape, 800 bpi density, retention or use license supplied | **$1,000** |
| **91DVV1P** DAS DesignLink Software Package for IBM PC, PC-DOS 2.0+, 9-track, 5 1/4 inch diskettes, retention or use license supplied | **$1,000** |

**Ask about 91DVV versions for other computers and operating systems.**

*DesignLink is a trademark of Tektronix, Inc.*

# TEK LOGIC ANALYZERS

## 1240/*NEW* 1241

GPIB IEEE-488 The 1240/1241 comply with IEEE Standard 488-1978, and with Tektronix *Standard Code and Formats*.

**Total Design Support: Hardware, Software, and Integration**

**1241's Color Display Enhances User Interface** See page 42B

**Up to 72 Acquisition Channels**

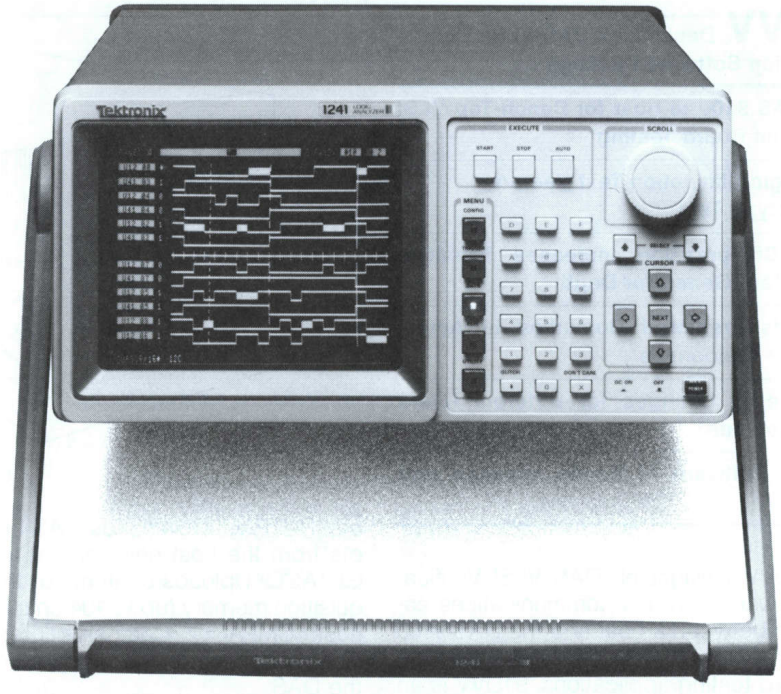
**Acquisition Speeds to 100 MHz Async, 50 MHz Sync**

**14 Levels of Triggering with Conditional Branching**

**Dual Time Base Triggering, Acquisition and Display**

**Simple Menu Operation with On-Screen Soft Keys**

**Transfers Easily into Manufacturing and Service**




### TOTAL PERFORMANCE

With the 1240/1241 Logic Analyzers, the key phrase is **total performance.** These instruments provide complete support for all aspects of the design task, including hardware analysis, software analysis, and integration.

The *NEW* 1241 color mainframe and 1240 monochrome mainframe provide rapid setup and operation. Use of either instrument is made simple through a straightforward menu-oriented approach, combined with multi-level operation and touch-screen soft keys. Multi-level operation allows the user to select from one of four levels best matched to the user's skill level and the task at hand. Touch-screen soft keys provide high-level commands at a keystroke, keeping operator selections simple and well labeled.

For hardware analysis, the 1240/1241 offer 100 MHz sampling, glitch triggering and autorun mode. Software analysis is supported by up to 72 channels, sophisticated clocking and 14 level triggering. These capabilities can be tied together through the unique dual time base feature to greatly speed hardware/software integration.

Both the 1241 with its LCCS (Liquid Crystal Color Shutter) display, and the 1240 have configurable architectures each with four card slots which accommodate any combination of 9 channel (1240D1) and 18 channel (1240D2) data acquisition cards, with a maximum of 72 channels. Data analysis and communications capabilities may be added through a series of plug-in ROM and COMM packs.

#### Hardware Analysis

For hardware analysis, the 1240/1241 offer up to 36 channels of acquisition at sampling rates of 100 MHz asynchronous and 50 MHz synchronous (see acquisition card descriptions). 6 ns glitch detection is also available.

Standard memory depth is 512 bits per channel, and this can be extended to a maximum of 2048 bits per channel by using a special memory chaining feature. This feature allows you to chain one card's memory to another, trading channel width for memory depth.

Superior hardware triggering capabilities include data and glitch triggering for isolating the problem area; clocked and unclocked triggering for capturing events that might not coincide with sample points; and counters, timers, and duration filters for triggering on the characteristics of a signal as well as its occurrence.

Auto-run capability is also provided. This feature allows you to track intermittents through continuous acquisitions. During the acquisitions, you can change parameters on the system under test and dynamically monitor their effects.

#### Software Analysis

Software analysis is supported by up to 72 data channels at sampling rates of 50 MHz synchronous/asynchronous (see acquisition card descriptions). A flexible clocking scheme includes data demultiplexing without double-probing.

Powerful software triggering capabilities are provided so you can track program flow. Included are 14 trigger levels, conditional branching, counters, timers, and both program flow and data flow qualification. These functions are implemented in two independent event recognizers.

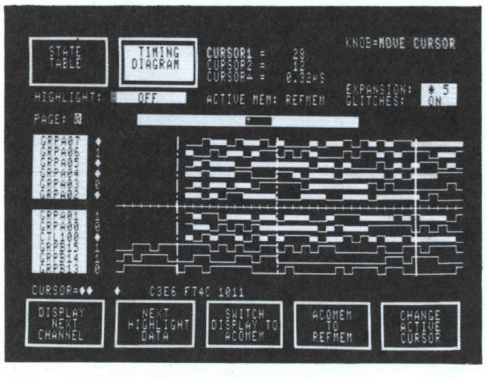



*Figure 1. Timing Diagram With Glitches.*

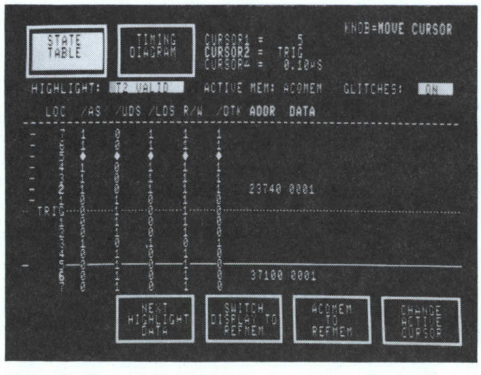



*Figure 2. State Table Display.*

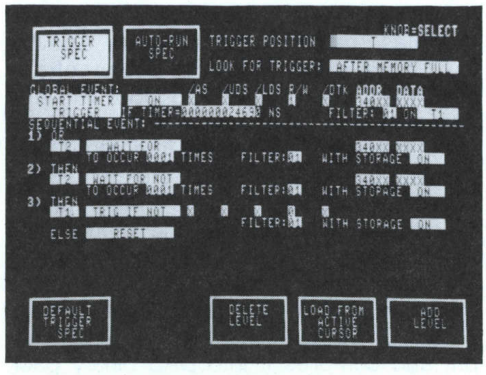



*Figure 3. Trigger Specification Menu.*

Other features that assist in software analysis are flexible channel groupings for display, standard display radices (including ASCII and EBCDIC), and an eight-level pattern search and memory compare with highlighting.

### Hardware/Software Integration

For integration, the 1240/1241 offer a dual time-base system that brings together all of the above hardware and software analysis capabilities. This dual time-base system greatly speeds the hardware/software integration process since the acquisition, triggering, and display of two independent time bases are tied together. You can fully monitor the interaction between hardware and software, or monitor the relationship of two interdependent systems. All data displays are time-aligned and completely correlated. The dual time base allows you to integrate functional modules, an increasingly important design task.

## FLEXIBILITY NOW AND IN THE FUTURE

The power of the 1240/1241 stem from its configurable mainframe. This mainframe houses a selection of data acquisition cards and plug-in ROM and COMM Packs. You can select features that meet your current application needs, then later upgrade the mainframe to increased performance.

### Selectable Acquisition Cards

The 1240/1241 mainframes provide four card slots that accommodate any combination of the following card types: 1240D1 and 1240D2.

The 1240D1 is a 9 channel data acquisition card that can sample at rates up to 100 MHz asynchronous and 50 MHz synchronous. This card also provides glitch capture down to 6 ns, on all channels.

The 1240D2 card is an 18 channel data acquisition card that can sample at rates up to 50 MHz asynchronous/synchronous. Another feature of this card is single-probe demultiplexing.

### ROM Packs for Data Processing

A ROM port on the side of the 1240/1241's mainframe supports the addition of special software ROM Packs. With the 1240/1241's acquisition capabilities, you have the capability to capture data which is very specific to your problem at hand. ROM Packs provide a means of helping you analyze that data, by processing it and presenting it to you in the most useful manner. Currently, there are ROM Packs supporting performance analysis, mnemonic disassembly of popular microprocessors, and special communications applications (see pages 116 to 118).

### COMM Packs for External Communications

Communication capabilities can be added to the 1240/1241 by inserting COMM Packs into a communications port on the rear of the instrument. These COMM Packs act as adaptors, allowing the 1240/1241 to function in different communication environments, including RS-232C and GPIB (see pages 117 and 118).

## EASE OF USE

In line with Tek's goal of easy-to-use logic analyzers, the 1240/1241 human interface has been designed to facilitate the user's operation of the instrument.

### Menu Operation and Soft Keys

Ease of use starts with the 1240/1241's menu operating system. Straightforward menu displays and on-screen soft keys allow you to make setup choices on the screen where your attention is already directed. You are not distracted by the need to look elsewhere on the instrument.

### Multiple Operation Levels

Another major feature of the menu operating system is user-selected operation levels. The 1240/1241 provide four operation levels, ranging from basic operation for simple applications to full operation for complex applications. The sophistication of system features increases with the operation levels.

### Configurable from the Front Panel

The 1240/1241 are completely configurable from the front panel, thus eliminating the need to switch boards and reconnect probes when changing from hardware to software applications. Probe connections are on the side of the instrument so they can be easily accessed. The keyboard has a simple layout, with single function keys. Also, a knob is included on the keyboard for data scrolling. This knob, along with the extreme smoothness of the data scrolling, make the 1240/1241 displays easier to read and manipulate.

*Figure 4. Scroll Knob*

### Automatic Nonvolatile Storage

A battery-backed CMOS memory stores two complete instrument setups, including the last setup used before the 1240 and 1241 are powered down. This facilitates quick instrument start-up when returning to work, and eliminates the problem of losing a setup as a result of power system interruptions.

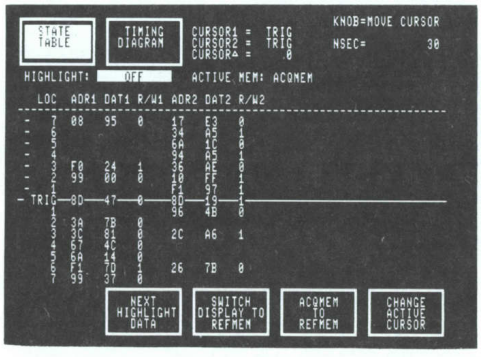



*Figure 5. State Table Display with Dual Time-base Acquisition.*

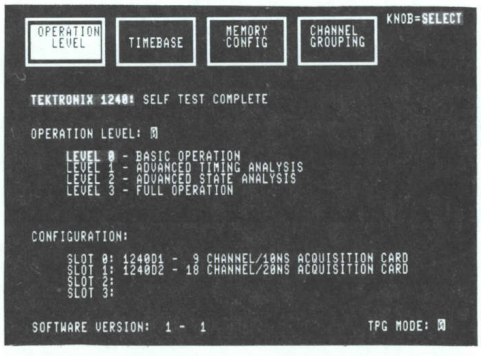



*Figure 6. Operation Level Menu*

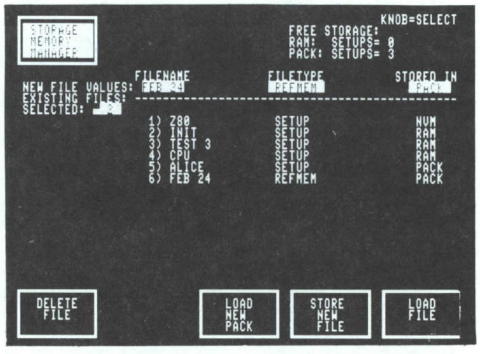



*Figure 7. Storage Memory Manager Menu.*

NEW

GPIB

LOGIC ANALYZERS

## IDEALLY SUITED FOR ENGINEERING, MANUFACTURING, AND SERVICE

In addition to its usefulness in the engineering environment, the 1240/1241 is well suited for manufacturing and service tasks. It transfers easily from one environment to another and helps facilitate communications between the different groups through its portability, remote control, mass storage and teleservicing capabilities.

### Portability

The 1241 weighs 12.7 kg (28.0 lb) and meets environmental Class 5 specifications. The 1240 weighs 12.0 kg (26.5 lb) and meets environmental Class 3 specifications.

### Remote Control

RS-232C and GPIB COMM Packs (see page 117), are ideally suited to automated test environments and remote control.

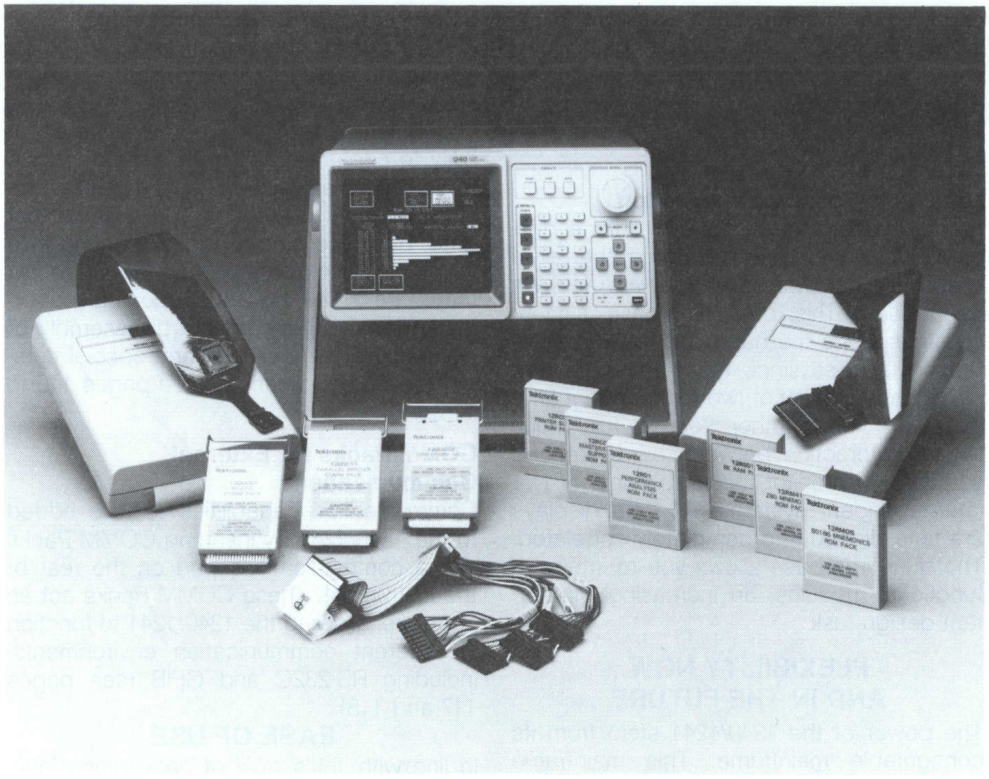
### Mass Storage

Mass storage of setups, acquisition memories, and reference memories is achieved through RAM and EPROM Packs. This type of pack storage allows engineering to easily transfer knowledge to other groups. They can create the setups and memories needed for design test in manufacturing, or they can create servicing procedures at the factory that can be sent out to field service sites.

Two types of pack storage are available. First, there is the 12RS01 8 k RAM Pack and the 12RS02 64 k RAM Pack. Storage and retrieval of information from this RAM Pack is accomplished via menu soft keys (see Figure 7). The 12RS11 32 k EPROM Pack (no EPROMs included) and the 12RS12 32 k EPROM Pack (EPROMs included) provide a permanent storage medium for setups and memories. To store files on these EPROM Packs, the setups and memories are uploaded from the 1240/1241 to a host computer via GPIB or RS-232C and then burned into EPROMs.

### Teleservicing

Master-Slave capability allows one 1240/1241 to remotely control another over a telephone line (see page 119). This greatly eases the higher levels of service troubleshooting, as service specialists can get to the problem via the telephone rather than having to physically travel to the problem site.



# 12RMXX

## Series Microprocessor Support

**Twenty-one Processors Supported**

**Single-Plug Connection for Ease of Use and Reliability**

**State Table Display in Four Formats: State, Absolute, Hardware and Software**

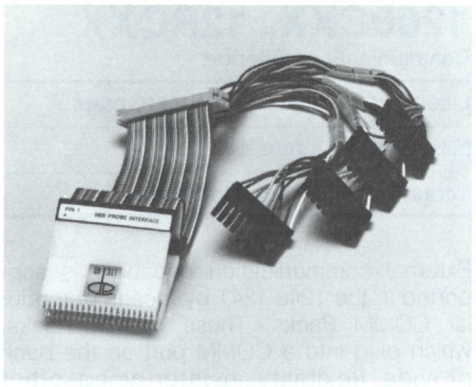
**Cursor Readout in Timing Diagram Displayed in Disassembly Format**

The 1240/1241 provide microprocessor support for major 8-bit, 16-bit and 32-bit processors. This support includes a single-plug interface, data acquisition capability and mnemonic disassembly.

For simple 8-bit and 16-bit processors, the 1240/1241 use general purpose clocking and demultiplexing capabilities to acquire the data for disassembly by the 12RMXX. Two 1240D2 cards using standard data acquisition probes (P6460 or P6462) are attached to the processor via a probe interface. See page 121 for information on the Configured Probe Interface. Three 1240D2 cards are required for the simple 16-bit processors.

For more complex 8-bit, 16-bit and 32-bit processors, the 1240/1241 use the PM200 Series of personality modules to interface to the processor and acquire the data for disassembly by the 12RMXX. These modules provide the special purpose hardware needed to properly acquire the instruction flow from a prefetch processor architecture and its associated internal queue. These modules plug directly into the 1240D2 cards, replacing the data acquisition probes and providing the interface to the processor. Three 1240D2 cards are required for these more complex processors. See page 121 for information on the PM 200 Series.

The microprocessor disassembly support for the 1240/1241 are in the form of Mnemonics ROM Packs (12RMXXs), with one ROM Pack for each microprocessor.



Four disassembly formats are available for viewing the data after disassembly: State, Absolute, Hardware, Software (only two display formats are available for the 68020: State and Absolute).

State format is exactly the same as standard State Table format.

Absolute format augments the State format with cycle operation labels (FETCH WRITE, etc.).

Hardware format provides disassembly information for all cycles occurring on the bus (instructions or cycle labels on all acquired cycles.)

Software format displays the executed instructions. It is similar to Hardware disassembly format with the display of instruction read cycles which are not opcode fetches suppressed. DMA's and flushed instructions are also suppressed.

**The processors that are currently supported by the 1240/1241 are:**

| | | |
|---|---|---|
| 6800 | 8080 | 6502/65C02 |
| 6802 | 8085 | |
| 6808 | 8086 | NSC 800 |
| 6809 | 8088 | |
| 68000 | 80186 | Z80 |
| 68008 | 80188 | Z8001 |
| 68010 | 80286 | Z8002 |
| 68020 | | F9450 |

For ordering information, please refer to the Microprocessor Support section on page 121.

# 12R01 Performance Analysis

**Two Types of Analysis: State Overview and Event Measurements**

**Monitor Memory Use, Execution Cycles, Subroutine Calls**

**Measure Time or Occurrences**

**Compare Statistics on Four Events, Analyze Distribution of Single Event**

**Measure Events Using Two Independent Time Bases**

Performance analysis is a tool that assists engineers in the development of microprocessor-based products. It can be used throughout the life cycle of a product to help the designer characterize, test, debug, and optimize software and system activity.

The real benefit of performance analysis over other types of development tools is that it provides nonintrusive overview measurements of system performance. In other words, it can be used to improve efficiency by providing measurements that characterize system performance without altering the performance.

The 12R01 Performance Analysis ROM Pack provides two types of performance analysis, State Overview and Event Measurement, for the 1240/1241. These two types of analysis provide overviews of the activity of the system under test, graphically displaying this activity in the form of histograms.

### State Overview

With State Overview, the user can acquire data on a set of defined ranges. Each range has a lower-bound value and an upper-bound value, and is defined for a specific group from the Channel Grouping menu. After a data acquisition is made (using the standard 1240/1241 triggering) each cycle of the acquired data is searched to find any matches between the channel groups and the ranges defined for them. A match occurs any time the value of a group at a given cycle is greater than or equal to the lower-bound value and less than or equal to the upper-bound value of a range associated with that group.

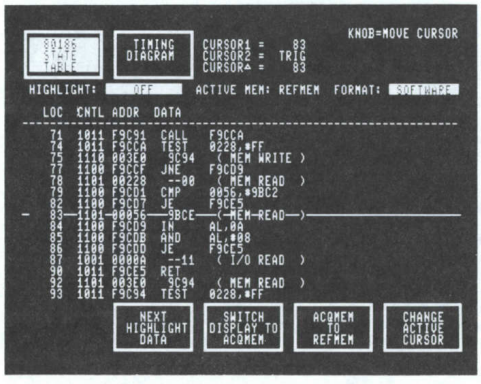



*Figure 8. 80186 Software Format.*

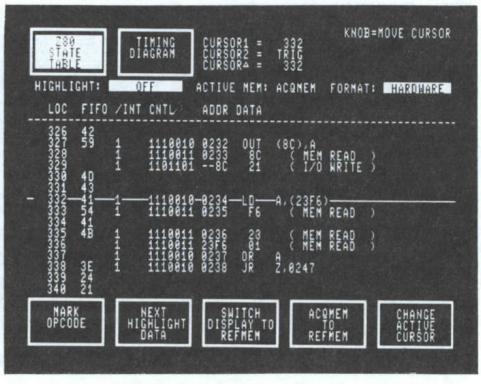



*Figure 9. Z80 Hardware Format with dual timebase acquisition.*

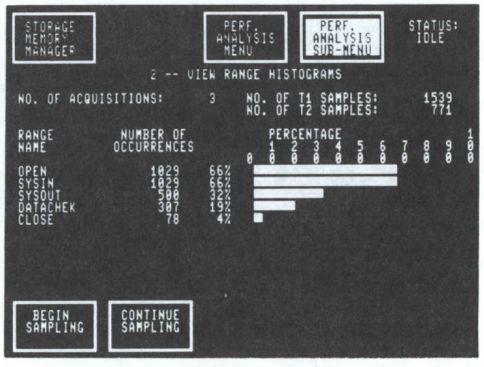



*Figure 10. View range histograms menu.*

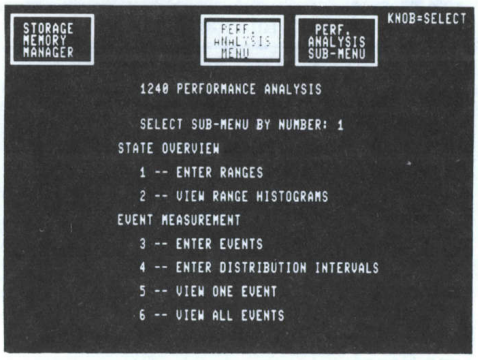



*Figure 11. Performance Analysis Menu.*

A cumulative count of the matches is kept for each range, and that count is displayed as a total count, a percentage of the total number of acquisition cycles on the associated channel group's given time base, and as a bar graph (histogram) proportional in length to that percentage. Up to eleven ranges can be defined.

### Event Measurement

With Event Measurement, the user is able to delimit the events that are to be analyzed. A measurement in this type of analysis consists of a start measurement event, an optional target event and a stop measurement event. The data acquired in a single occurrence of the start measurement/stop measurement cycle is defined as a sample". When sampling begins, the 1240/1241 repeatedly takes the same kind of measurement sample until the user stops the instrument. Within each sample, some type of measurement takes place, and this information is then processed for display.

The target event may be a single event that the user wishes to count occurrences of or time. It can also be two events, in which case the 1240/1241 will measure the time between them. If no target event is chosen, the duration of each sample can be timed, or the number of clock cycles that occur on a given time base during each sample can be counted. Up to four events can be defined.



# 1200CXX, 12RCXX

## Communications Support

### Line Printer Support for Most Printers

### Master/Slave Support

### Three Communication Interfaces

External communication capability is supported in the 1240/1241 by means of modular COMM Packs. These COMM Packs, which plug into a COMM port on the back provide flexibility in interfacing other equipment.

### REMOTE CONTROL

Two COMM Packs are provided to interface the 1240/1241 to controllers, the 1200C01 RS-232C COMM Pack and the 1200C02 GPIB COMM Pack. You can remotely control all of the capabilities of the 1240/1241 using these COMM Packs.

The controller can start and stop data acquisitions and the auto-run function, write to the display, define custom soft keys, request 1240/1241 keystrokes, and initiate and request diagnostic results. Instrument setups, acquisition memories, reference memories and RAM Pack contents can be sent and received from the 1240/1241, also.

Requests from the 1240/1241 to upload and download setups and memories are initiated via soft keys (see figure 14).

The 1200C02 GPIB COMM Pack interface conforms to IEEE specification 488-1978, Standard Digital Interface for Programmable Instrumentation. The 1240/1241 operates via the GPIB COMM Pack with the Tek 4041 controller.

### PRINTER SUPPORT

Through the use of a ROM Pack and COMM Pack combination the 1240/1241 are able to print hard copies of setup menus and data acquisition memories. Support will be provided for almost all commercially available low-cost printers (see figure 15).

The printer interface consists of the combination of a ROM Pack and a COMM Pack. The 12RC01 Printer Support ROM Pack is used in combination with either the 1200C01 RS-232C COMM Pack (for printers with a serial interface) or the 1200C11 Parallel Printer COMM Pack (for printers with a parallel interface).

Nearly all screen displays can be printed including Operation Level, Time Base, Memory Configuration, Channel Grouping, Trigger Spec, Auto-Run Spec, State Table, and Timing Diagram. In addition, a special combined state and timing format is available.

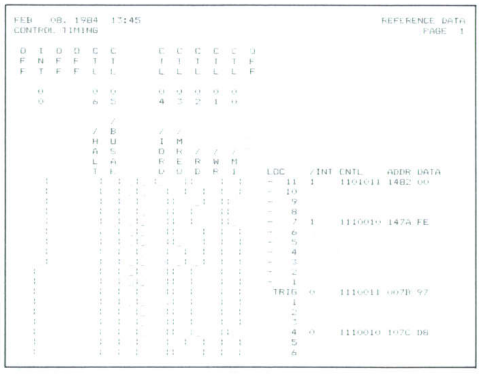


*Figure 12. Combined Format Print-out.*

The Printer ROM Pack also has the ability to print a single display as it appears on the screen. Other functions available are the search pattern, user defined timing trace labels up to 45 characters long for timing diagram printouts, and a printer test to check connections and printer operation.

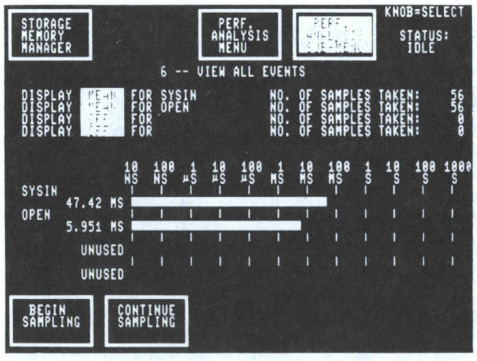



*Figure 13. View all events menu.*

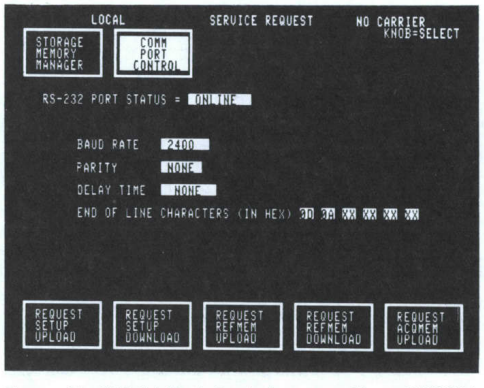



*Figure 14. COMM Port Control menu with a 1200C01 RS-232C COMM Pack installed.*

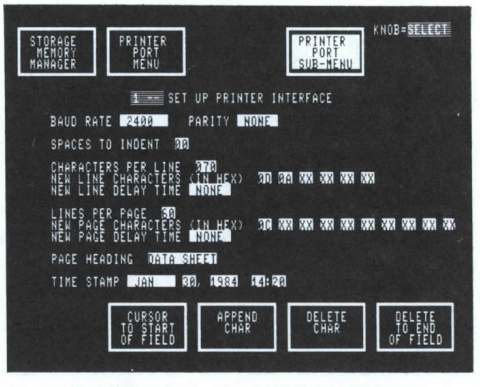



*Figure 15. Printer Port sub-menu for setting up printer interface parameters.*

## TELESERVICING

Master-Slave capability allows one 1240/1241 to remotely control another over a telephone line. This greatly eases the higher levels of service troubleshooting, as service engineers can get to the problem via the telephone rather than having to physically travel to the problem site.

A phone link between the master 1240/1241 and the slave 1240/1241 can be used for sending both data and voice information. When in data mode, the master 1240/1241 has complete control over the slave, with the ability to: send and receive set-ups, acquisition memories and reference memories, start and stop acquisitions, start and stop auto-acquisition; receive information on whether the memories were equal or not equal after auto-acquiring; initialize the slave; get the slave's status; and have the slave call the master when an acquisition or auto-acquisition is over.

In voice mode, the service engineer at the master 1240/1241 can speak directly with the technician at the slave end and direct him to move probes or to swap boards. Switching between voice and data mode is accomplished through the master/slave menu when the Option 01 modem is used.

Also available with the Option 01 modem are auto-answer and auto-dial. With auto-answer, an unattended 1240/1241 will respond to a call from another 1240/1241. A master-slave connection can thus be set up without a service technician present at the slave end.

With auto-dial, a slave 1240/1241 can be set up to automatically call the master upon triggering. If troubleshooting an intermittent problem, the slave can be set to trigger on the problem, the service technician can leave the slave site, the line can be disconnected, and when the intermittent occurs, the slave will call the master, and the service engineer can analyze the data.

The 1240/1241 supports master/slave operation with the following configuration: A 12RC02 Master/Slave ROM Pack, a 1200C01 RS-232C COMM Pack and a modem.

Each 1240/1241 must have at least one acquisition card (1240D1 or 1240D2) installed. Once the connection between the master and a slave is established, the master will assume the card configuration of the slave until it's power is turned off or until a connection is established with another slave.

The Option 01 Hayes Smartmodem 1200 is recommended for use with master/slave support in the United States, and other countries where it's licensed. With this modem, the user has access to the following features through the front panel: auto-dial of up to four phone numbers, auto-answer, and soft-key switching between voice and data communication modes. This modem is not licensed in all countries, however in these countries the 12RC02 and 1200C01 can be used with many full-duplex modems. With modems other than the Hayes Smartmodem 1200, the telephone connection must be made by hand, and auto-dial, auto-answer, and soft-key switching between voice and data modes do not function.

## EXTERNAL COMMUNICATION SUPPORT

To equip the 1240/1241 for one of the three types of communications support shown across the top of this table, choose one of the combinations of ROM Pack and COMM Pack whose intersection is indicated by XXXX's. Performance varies depending on the combination of packs that you select for a particular kind of support.

| | Remote Control | Printer Support | Master/ Slave Support |
|---|---|---|---|
| ROM Packs | None Required | 12RC01 Printer Support | 12RC02 Master/ Slave |
| COMM Packs | | | |
| 1200C01 RS-232C | XXXX | XXXX | XXXX |
| 1200C02 GPIB | XXXX | | |
| 1200C11 Parallel Printer | | XXXX | |

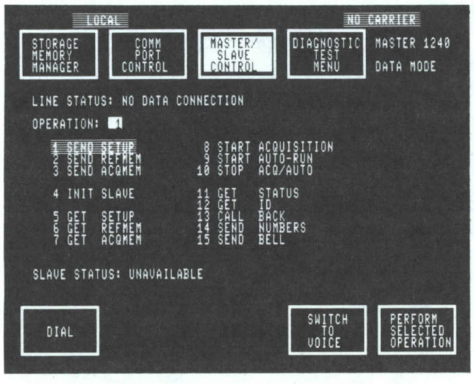



*Figure 16. Master/Slave Control Menu.*

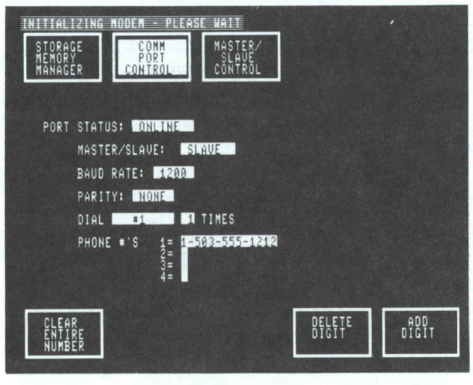



*Figure 17. Comm Port Control Menu*

# TEK LOGIC ANALYZERS



## CHARACTERISTICS

Characteristics are common to the 1240/1241 unless otherwise indicated.

### OPERATING LEVELS

**Level 0** — Basic Operation.
**Level 1** — Advanced timing analysis (includes basic state analysis).
**Level 2** — Advanced state analysis (includes basic timing analysis).
**Level 3** — Full operation.

### TIME BASES

**Two Per Instrument** — Assignable by probe. Time Base 1: Asynchronous or Synchronous. Time Base 2: Synchronous or Demultiplex.

### INPUTS

**Clocks** — C1, C2, . . . Cn. Where n = number of probes = number of channels/9. Minimum Pulse Width: 8 ns. Specifiable as rising, falling, or either edge.

**Qualifiers** — Q1, Q2, . . . Qn. Where n = number of probes = number of channels/9. Setup Time, Hold Time: = (P6460) 11 ns, 0 ns; (P6462) 17 ns, 6 ns. Specifiable as high or low level.

**Asynchronous** — Rate: 1240D1: 10 ns to 1 s, (1240D2: 20 ns to 1 s). Specification: (1-2-5 sequence) • (Q1 • Q2 • . . . • Qn). Accuracy: 0.01%. Channel-to-Channel Skew: ±3 ns. Glitch Detection: (1240D1 only) 6 ns.

**Synchronous** — Rate: Dc to 50 MHz. Setup Time, Hold Time: On 1240D1 is (P6460) 7 ns, 2 ns; (P6462) 12 ns, 7 ns. On 1240D2 is (P6460) 12 ns, 0 ns; (P6462) 17 ns, 5 ns. Specification: (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After Previous Clock: 20 ns.

**Demultiplex** — Rate: Dc to 50 MHz. Setup Time, Hold Time: On 1240D1 is (P6460) 7 ns, 2 ns; (P6462) 12 ns, 7 ns. On 1240D2 is (P6460) 12 ns, 0 ns; (P6462) 17 ns, 5 ns. Specification: First Phase Clock (Latch Data) (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After Last Phase Clock: 20 ns. Last Phase Clock (Store Data): (C1 + C2 + . . . + Cn) • (Q1 • Q2 • . . . • Qn). Minimum Delay After First Phase Clock: 10 ns.

### CONFIGURABILITY

Two types of acquisition cards: 1240D1, 1240D2. Maximum of four cards per 1240/1241, in any combination.

| | 1240D1 | 1240D2 |
|---|---|---|
| Number of Channels | 9 | 18 |
| Asynchronous Rate<br>with glitches | 100 MHz<br>50 MHz | 50 MHz<br>N/A |
| Synchronous Rate | 50 MHz | 50 MHz |
| Memory Depth<br>(Bits/Char Channel<br>with Glitches | 512<br>256 | 512<br>N/A |
| Max Via Chaining | 2048 | 2048 |

**Depth vs Channels** — Tradeoffs possible between data acquisition cards of same type. Maximum depth is 2048 (with four 1240D1 or four 1240D2).

### DATA ACQUISITION

Two Types of Acquistion Probes: P6460, P6462. One probe required per 1240D1, two per 1240D2.

| | P6460 | P6462 |
|---|---|---|
| Signal Input | | |
| Data Channels | 9 | 9 |
| Clock/<br>Clock Qualifier Lines | 1 | 1 |
| Impedence | | |
| Nominal | 1 MΩ, 5 pF | ≈1 LTTL |
| Threshold Range | −6.35 V to +6.35 V | +1.4 V |
| Increments | 0.05 V | — |
| Accuracy | ±0.5%<br>±0.065 V | ±.25 V<br>+.055 V/<br>(0°C −25°C) |
| Threshold Assignment | By acquisition card | N/A |
| Polarity Assignment | By channel | By channel |
| Maximum Input Voltage | | |
| Peak | ±40 V | −2 to +7 V |
| Channel to Channel | ±60 V | No restriction |

*NOTE: All system specifications are based upon P6460 probes, for specifications based upon P6462 probes, please refer to the 1240/1241 Data Sheet.*

### TRIGGER DEFINITION (TWO EVENT RECOGNIZERS)

**Global Event Recognizer (Event Recognizer #1)** — One level. Event Recognition specified by: Word recognizer—data (data or glitch on 1240D1). Duration filter—1 to 16 consecutive samples or 10 ns to 160 ns. Commands: Store On (Not), Trigger On (Not), Reset On (Not), Start Timer On (Not), Time While On (Not), Increment Counter On (Not), or Off. Counter/timer: Clock interval is 10 ns. Range is 0 to 99,999,999,999 (either counts or 10 ns increments) Counter/timer value may be used to cause trigger or reset.

**Sequential Event Recognizer (Event Recognizer #2)** — 14 levels. Event Recognition on Each Level Specified By: Time Base: Which time base to monitor for event. Word Recognizer: Data (data or glitch on 1240D1). Iteration Counter: 1 to 9999 occurrences. Duration Filter: 1 to 16 consecutive samples. Selective Storage on Each Level Specifiable: With Storage On or with Storage Off. Commands on Each Level: Wait For (Not), Trigger If (Not), Reset If (Not), Jump If (Not) or Delay (up to 9999). Commands at End of Sequence: Trigger, Reset or Do Nothing.

**External Trigger Out** — TTL level output whenever trigger attempted.

**External Trigger In** — TTL level input can be required for enabling trigger.

### AUTORUN

**Modes of Operation** — Compare Acquisition Memory to Reference Memory: Specifiable which channels to compare, specifiable starting and ending memory locations of comparison. Result of Comparison Outcome: Specifiable display and reacquire, discard and reacquire, or display and stop. Specifiable Minimum Display Time: 0 s to 99 s.

**Continuous Trigger Out** — Data is not stored. 1240/1241 acts as trigger source.

**Trigger In** — Requires trigger in signal to enable trigger. Enables two 1240/1241s to work in parallel.

**Store After Trigger** — Data at last trigger is available after stopping 1240/1241. Time between storages is minimum.

### DISPLAY FORMATS

**State Table** — Acquisition or reference memory. Data displayed in binary, octal, hex, ASCII, EBCDIC. Glitch display can be turned on or off.

**Timing Diagram** — Acquisition or Reference Memory. Horizontal Expansion: *1, *2, *5, *10, *20. Vertical Expansion: (1241 only): *1, *2.

**Distance Between Cursors** — Value displayed as absolute time for unqualified asynchronous measurement, as number of memory locations for qualified or synchronous measurement.

**Highlighting Modes** — Memory comparison differences, glitches, search pattern occurrences, time base #1 occurrences, time base #2 occurrences.

**Search Pattern** — Length: 1 to 8 contiguous locations. Time Bases: Can restrict each location to occur only on T1, T2 or T1 and T2.

### STORAGE

**Internal (Standard)**
**Nonvolatile Memory (NVM)** — Size: Contains two set-ups, including status at power down, lithium iodide battery.

**Volatile Memory (RAM)** — Size: Contains two set-ups.

**Memory Types**
**Set-Up** — Stored in NVM, RAM, or Pack, contains all data pertinent to making an acquisition.

**Reference Memory** — Stored in Pack, reference memory is editable in Edit Reference Memory menu.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: (1240 only) −10°C to +55°C; (1241 only) 0°C to 50°C. Nonoperating: −62°C to +85°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — 0.025 inch displacement. 10 Hz to 55 Hz frequency range.
**Shock** — 30 g.

### OTHER CHARACTERISTICS

**Diagnostics** — At power-up, the 1240/1241 perform processor, ROM, RAM and board checks. A test pattern generator located on the side provides stimulus for verifying probes and acquisition system operation. Complete system verification and extended diagnostics are available with an optional ROM Pack.

**Rear Panel Connections** — Trigger In: TTL compatible. Trigger Out: TTL compatible. Video Out: (1240 only) Confroms with RS-170 (composite video).

**Power** — 90 V to 132 V or 180 V to 250 V, 48 Hz to 63 Hz.
*NOTE: 48 Hz to 440 Hz operation with addition of safety ground strap.*

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 368 | 14.5 |
| Height | 197 | 7.8 |
| Depth | 498 | 19.6 |
| **Weight** | **kg** | **lb** |
| Without Accessories | 12.0 | 26.5 |

## COMM Packs

**1200C01 (RS-232C)** — Baud Rate: 110 to 9600. Bits/Character: Eight, including parity bit. Protocol: Asynchronous full duplex. Compatability: Stand-alone with host for remote control, with 12RC01 for printers with serial interface, with 12RC02 and 12RC02 Option 01 for master/slave, with 12RMXX for printers with serial interface.

**1200C02 (GPIB)** — Full listener/talker capabilities. Meets IEEE Standard 488-1978. Compatability: Stand-alone with host for remote control.

**1200C11 (Parallel Printer)** — Compatability: With 12RC01 for printers with parallel interface, with 12RMXX for printers with parallel interface.

## ROM Packs

**Analysis**

**12R01 (Performance Analysis)** — State Overview: 1 to 11 ranges. Ranges can be different groups and different timebases. Ability to halt and resume measurement. Display in count, percentage, and histogram. Event Measurement: 1 to 11 distribution intervals. 1 to 4 events. 10 ns resolution. Five measurement types (measure total time, count cycles, count occurrences, time occurrence, accumulate time). Display in distribution, min, mean, max, and histogram.

**Communication Support**

**12RC01 (Printer Support)** — Requires: 1200C01 for serial interface or 1200C11 for parallel interface. Output: Menus, search pattern, acquisition and reference memory. Memory Format: State table, timing diagram, and combined.

**12RC02 (Master/Slave)** — Requires: 1200C01 and modem. With Option 01: Auto-answer, autodial, voice-data switching, non-volatile storage of four phone numbers, 300 baud and 1200 baud. Diagnostics: Local 1240/1241 with COMM Pack and RS-232 cable, modem, and link between local and remote 1240/1241.

**External Storage (Optional)**

**12RS01 (8 k RAM Pack)** — Size: Contains 8 kbytes with Lithium battery.

**12RS02 (64 k RAM Pack)** — Size: Contains 64 kbytes with Lithium battery.

**12RS11 (32 k EPROM Pack)** — Size: Contains 32 kbytes (no EPROMs included). Requires four 68764s or 68766s.

**12RS12 (32 k EPROM Pack)** — Size: Contains 32 kbytes. Comes with four 68764s or 68766s.

**Microprocessor Support**

**12RMXX (Mnemonic Disassembly)** — Formats: State, Absolute, Hardware, Software.

## ORDERING INFORMATION

**1240** Logic Analyzer Mainframe **$4,500**

**Includes:** Accessory pouch (016-0707-00); front panel cover (200-2780-00); operator manual (070-4340-01); reference guides (070-4641-01).

**1241** Color Logic Analyzer Mainframe **$6,000**

**Includes:** Same as above.

**Option 05** — Rackmount Adaptor. **+$400**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### STANDARD SYSTEM CONFIGURATIONS

#### 8-BIT

**1240N08** — 8-Bit Microprocessor Analysis System **$12,400**

**Includes:** 1240 Logic Analyzer with two 1240D2 modules with four P6460 probes, 12RS02 RAM Pack.

**1241N08** — 8-Bit Microprocessor Analysis System **$13,900**

**Includes:** Same as above except the 1241 Logic Analyzer.

#### OPTIONS

**Options 01 thru 09** — Microprocessor Specific Support (Includes: 12RMXX Microprocessor Disassembly ROM Pack, 12RMXX Option 01 Configured Probe Interface).

**Option 01** — Specific Support for 8080. **+$600**
**Option 02** — Specific Support for 8085. **+$600**
**Option 03** — Specific Support for 6800. **+$600**
**Option 04** — Specific Support for 6802. **+$600**
**Option 05** — Specific Support for 6808. **+$600**
**Option 06** — Specific Support for 6809. **+$600**
**Option 07** — Specific Support for Z80. **+$600**
**Option 08** — Specific Support for 6502. **+$600**
**Option 09** — Specific Support for NSC800. **+$600**

#### 16-BIT

**1240N16** — 16-Bit Microprocessor Analysis System **$12,600**

**Includes:** 1240 Logic Analyzer with three 1240D2 Option 1D Modules without probes, P6460 Probe, 12RS02 RAM Pack.

**1241N16** — 16-Bit Microprocessor Analysis System **$14,100**

**Includes:** Same as above except the 1241 Logic Analyzer.

#### OPTIONS

**Options 01 thru 09** — Microprocessor Specific Support (Includes: 12RMXX Microprocessor Disassembly ROM Pack, 12RMXX Option 02 or Option 04 Personality Module).

**Option 01** — Specific Support for 8086. **+$2,500**
**Option 02** — Specific Support for 8088. **+$2,500**
**Option 03** — Specific Support for 80186. **+$2,500**
**Option 04** — Specific Support for 80188. **+$2,500**
**Option 05** — Specific Support for 68000 (DIP). **+$2,500**
**Option 06** — Specific Support for 68000. (PGA). **+$2,500**
**Option 07** — Specific Support for 68008. **+$2,500**
**Option 08** — Specific Support for 68010 (DIP). **+$2,500**
**Option 09** — Specific Support for 68010 (PGA). **+$2,500**

### GENERAL PURPOSE

**1240NGP** — General Purpose Analysis System **$15,350**

**Includes:** 1240 Logic Analyzer with 1240D1 module with P6460 probe, two 1240D2 modules with four P6460 probes, 12RS02 RAM Pack.

**1241NGP** — General Purpose Analysis System **$16,850**

**Includes:** Same as above except the 1241 Logic Analyzer.

### BUS ANALYSIS

**1240NBA** — Bus Analysis System **$19,800**

**Includes:** 1240 Logic Analyzer with four 1240D2 modules with eight P6460 probes, 12RS02 RAM Pack.

**1241NBA** — Bus Analysis System **$21,300**

**Includes:** Same as above except the 1241 Logic Analyzer.

### HIGH SPEED ANALYSIS

**1240NHS** — High Speed Analysis System **$16,800**

**Includes:** 1240 Logic Analyzer with four 1240D1 Modules with four P6460 probes, 12RS02 RAM Pack.

**1241NHS** — High Speed Analysis System **$18,300**

**Includes:** Same as above except the 1241 Logic Analyzer.

## OPTIONAL ACCESSORIES

### ACQUISITION CARDS

**1240D1** — 9-Channel Data Acquisition Card, 100 MHz, includes one P6460 data acquisition probe. **$2,950**

**Option 1D** — Deletes one P6460 Data Acquisition Probe. **−$700**

**1240D2** — 18-Channel Data Acquisition Card, 50 MHz, includes two P6460 data acquisition probes. **$3,700**

**Option 1D** — Deletes two P6460 Data Acquisition Probes. **−$1,400**

**Option 2S** — Substitutes two P6462 Data Acquisition for two P6460 Data Acquisition Probes. **−$720**

### DATA ACQUISITION PROBES

**P6460** — 9-Channel Data Acquisiton Probe. **$700**
**P6462** — 9-Channel Data Acquisiton Probe, fixed threshold TTL. **$340**

### COMMUNICATION INTERFACES

#### COMM PACKS

**1200C01** — RS-232C COMM Pack. **$750**
**1200C02** — GPIB COMM Pack. **$850**
**1200C11** — Parallel Printer COMM Pack. **$500**

Note: To order cables for these COMM Packs, see the Logic Analyzer Accessories Section.

### ROM PACKS

**Analysis**
**12R01** — Performance Analysis ROM Pack. **$800**

**Communication Functions**
**12RC01** — Printer Support ROM Pack. **$300**
**12RC02** — Master/Slave ROM Pack. **$500**
**Option 01** — Modem. **+$600**

**Storage**
**12RS01** — 8 k RAM Pack. **$300**
**12RS02** — 64 k RAM Pack. **$500**
**12RS11** — 32K EPROM PACK (Empty). **$85**
**12RS12** — 32K EPROM PACK. **$300**

### SERVICE ACCESSORIES

**12RD01** — Diagnostic ROM Pack. **$1,500**
**Diagnostic Lead Set** — Order 012-0556-00 **$50**
**Extender Card** — Order 670-7539-02 **$400**
**Service Manual** — Order 062-7124-02 **$150**
**Service Maintenance Kit** — Includes the above service accessories. Order 067-1103-02 **$2,000**

### CARTS

**Portable Instrument Cart** — For on site portability. Order K212. See page 423 for complete description. **$330**

**Instrument Shuttle** — For site-to-site portability. Order K117. See page 423 for complete description. **$265**

# Microprocessor and Bus Support

**Standard Modules for Many Microprocessors**

**Single-Plug Connection for Ease of Use and Reliability**

**Ready-to-Use Mnemonics on Tape or ROM Pack**

**PM200 Personality Modules for Advanced Microprocessors**

*The Option 01 probe interface works with the mnemonics files on tape or ROM pack to support disassembly on the DAS 9100 and the 1240.*

Tektronix logic analyzers offer wide-ranging microprocessor support with a selection of single-plug connectors and mnemonic disassembly packages.

For custom microprocessors, or microprocessors not listed below, Tektronix offers support through EDM (Extended Define Mnemonics) on the DAS 9100. Also, the Universal Probe Interface Kit (UPIK40) on page 131 is a general-purpose, single-plug connection.

In addition to microprocessors, Tektronix offers support for several popular bus implementations, including the UNIBUS, the Q-BUS, and the GPIB (IEEE Standard 488), and the ASCII and EBCDIC character codes.

Table A contains information about the microprocessor support available for the 1240/1241. Table B describes the microprocessor support on the DAS 9100, using 91A24 Data Acquisition Modules. Table C covers bus support on the DAS 9100, again using 91A24 modules.

## TABLE A: 1200 SERIES ORDERING AND CONFIGURATION GUIDE

| Microprocessor | For Mnemonics ROM Pack Order | For Probe Interface Order | For PM200 Support Order | Total No. 1240D2's Required | Total No. Probes*1 Required | Processor Clock Rate Supported |
|---|---|---|---|---|---|---|
| 8080 | 12RM01 | Opt 01 | | 2 | 4 | Max |
| 8085 | 12RM02 | Opt 01 | | 2 | 4 | Max |
| 8086 (DIP) | 12RM03 | | Opt 02 | 3 | None | 8 MHz |
| 8088 (DIP) | 12RM04 | | Opt 02 | 3 | None | 8 MHz |
| 80186 (LCC) | 12RM05 | | Opt 02 | 3 | None | 8 MHz |
| 80188 (LCC) | 12RM06 | | Opt 02 | 3 | None | 8 MHz |
| 80286 (LCC) | 12RM08 | | Opt 02 | 3 | None | 10 MHz |
| 6800 | 12RM21 | Opt 01 | | 2 | 4 | Max |
| 6802 | 12RM22 | Opt 01 | | 2 | 4 | Max |
| 6808 | 12RM23 | Opt 01 | | 2 | 4 | Max |
| 6809 | 12RM24 | Opt 01 | | 2 | 4 | Max |
| 68000 (DIP) | 12RM25 | | Opt 02 | 3 | None | 12.5 MHz |
| 68000 (PGA) | 12RM25 | | Opt 04 | 3 | None | 12.5 MHz |
| 68008 (DIP) | 12RM26 | | Opt 02 | 3 | None | 8 MHz |
| 68010 (DIP) | 12RM27 | | Opt 02 | 3 | None | 12.5 MHz |
| 68010 (PGA) | 12RM27 | | Opt 04 | 3 | None | 12.5 MHz |
| 68020 (PGA) | 12RM31 | | Opt 02 | 3 | None | 16.7 MHz |
| Z80 | 12RM41 | Opt 01 | | 2 | 4 *3 | Max |
| Z8001/Z8003 | 12RM42 | | | 3 | 4 | Max |
| Z8002/Z8004 | 12RM43 | Opt 01 | | 3 | 3 | Max |
| 6502/65C02 | 12RM63 | Opt 01 | | 2 | 4 *2 | Max |
| F9450 (1750A MIL STD) | 12RM62A | | | 3 | 3 | Max |
| NSC800 | 12RM71 | Opt 01 | | 2 | 4 *3 | Max |

**1 For most of the above processors, either P6460 or P6462 Data Acquisition probes can be used.*
**2 P6460's are required if you're using a CMOS version of the processor.*
**3 P6460's are always required.*

## ORDERING INFORMATION

**For all items in Table A, prices are as follows:**

**12RMXX** Mnemonics ROM Pack **$400**

**OPTIONS**

**Option 01** — Probe Interface. **+$200**
**Option 02** — PM200 Support. **+$2,100**
**Option 04** — PM200 Support. **+$2,100**

**DAS 9100 Microprocessor Support**
Microprocessor disassembly requires a 91TM mnemonics tape along with a 91A24 and a 91AE24 acquisition module. An easy-to-use single-plug probe adaptor (Option 01) is available for most 8-bit processors. Intel and Motorola 16-bit processors require PM200 Series Personality Modules (Options 02 or 04). The PM200s provide fetch indication, queue tracking and clock synthesis in addition to single-plug connection and built-in acquisition probes (91A24/91AE24 modules are available without probes for dedicated PM200 use). Note that DAS 9100 Option 01 (DC 100 Tape Drive) is required to use these microprocessor support packages.

## TABLE B: DAS 9100 SERIES ORDERING AND CONFIGURATION GUIDE

| Microprocessor | REQUIRED For Disassembly Tape Order | OPTIONAL For Probe Interface Order | REQUIRED For PM 200 Module Order | Total No Probes*1 Required | Processor Clock Rate Supported |
|---|---|---|---|---|---|
| 8080 | 91TM01 | Opt 01 | N/A | 4 | Max |
| 8031 | 91TM07 | Opt 01 | N/A | 4*5 | Max |
| 8039*2 | 91TM10 | Opt 01 | N/A | 3*5 | Max |
| 8085 | 91TM02 | Opt 01 | N/A | 4 | Max |
| 8086 (DIP) | 91TM03 | N/A | Opt 02 | None | 10 MHz |
| 8088 (DIP) | 91TM04 | N/A | Opt 02 | None | 10 MHz |
| 80186 (LCC) | 91TM05 | N/A | Opt 02 | None | 10 MHz |
| 80188 (LCC) | 91TM06 | N/A | Opt 02 | None | 10 MHz |
| 6800 | 91TM21 | Opt 01 | N/A | 4 | Max |
| 6801 | 91TM28 | Opt 01 | N/A | 4 | Max |
| 6802 | 91TM22 | Opt 01 | N/A | 4 | Max |
| 6803 | 91TM29 | Opt 01 | N/A | 4 | Max |
| 6805*3 | 91TM30 | UPIK40 | N/A | 4*4 | Max |
| 6808 | 91TM23 | Opt 01 | N/A | 4 | Max |
| 6809 | 91TM24 | Opt 01 | N/A | 4 | Max |
| 68121 | 91TM32 | N/A | N/A | 4 | Max |
| 68000 (DIP) | 91TM25 | N/A | Opt 02 | None | 12.5 MHz |
| 68000 (PGA) | 91TM25 | N/A | Opt 04 | None | 12.5 MHz |
| 68008 (DIP) | 91TM26 | N/A | Opt 02 | None | 8 MHz |
| 68010 (DIP) | 91TM27 | N/A | Opt 02 | None | 12.5 MHz |
| 68010 (PGA) | 91TM27 | N/A | Opt 04 | None | 12.5 MHz |
| Z80 | 91TM41 | Opt 01 | N/A | 4*5 | Max |
| Z8001/03 | 91TM42 | N/A | N/A | 4 | Max |
| Z8002/04 | 91TM43 | Opt 01 | N/A | 3 | Max |
| 6502/65C02 | 91TM63 | Opt 01 | N/A | 4*4 | Max |
| 1802 | 91TM61 | Opt 01 | N/A | 4*4 | Max |
| 1805 | 91TM65 | Opt 01 | N/A | 4*4 | Max |
| F9450 | 91TM62 | N/A | N/A | 3 | Max |
| 1750A | 91TM64 | N/A | N/A | N/A | N/A |
| NSC 800 | 91TM71 | Opt 01 | N/A | 4*5 | Max |

*1 *For most of the above processors, either P6460 or P6462 data acquisition probes can be used.* *2 *Requires only 91A24.* *3 *Supports the MC146805E2.*
*4 *P6460's are required if you're using a CMOS version of the processor.* *5 *P6460's are always required.*

## ORDERING INFORMATION

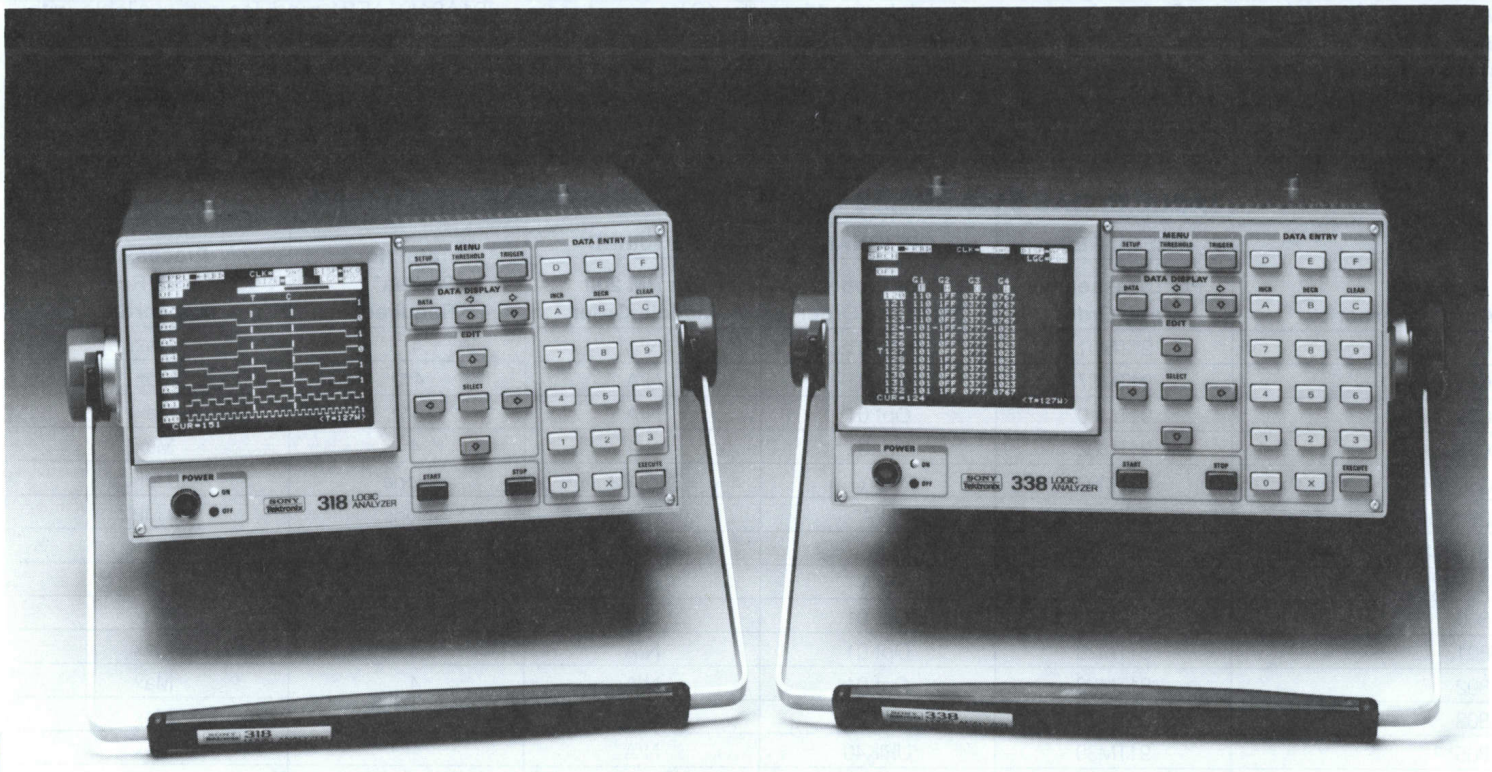
**For items in Table B above, prices are as follows:**
**91TMXX** Mnemonics Tape **$350**
**Option 01** — Probe Interface. **+$200**

**Option 02** — PM200 Support. **+$2,100**
**Option 04** — PM200 Support. **+$2,100**
**UPIK40** — Universal Probe Interface Kit, 40-pin DIP **+$175**

**For items in Table C below, prices are as follows:**
**91TM51 or 91TM52** Mnemonics Tape **$350**
**91TM53** Mnemonics Tape **$200**
**Option 01** — Probe Adaptor **+$180**

## TABLE C: DAS 9100 SERIES BUS SUPPORT ORDERING AND CONFIGURATION GUIDE

| Bus/Code | For Mnemonics Tape Order | For Probe Interface Order | Total No. 91A24 & 91AE24's Required | Total No. Probes Required | Bus Clock Rate Supported |
|---|---|---|---|---|---|
| UNIBUS | 91TM51 | | 2 | 4 | Max |
| Q-BUS | 91TM52 | | 2 | 4 | Max |
| GPIB/ASCII/EBCDIC | 91TM53 | Opt 01 | 1 | 3 | Max |






## 318/338 Logic Analyzers

**Superior Performance/Price Ratio**

**Parallel and Serial Data Acquisition in a Single Instrument**

**Data Widths to 32 Channels and Acquisition Speeds to 50 MHz**

**Menu-Driven User Interface for Easy Operation**

**Powerful Multilevel Triggering**

**Separate Glitch Trigger and Memory**

**RS-232 Interface Allows Remote Control**

**Nonvolatile Memory Retains Both Reference Data and Instrument Setups**

**Ultra-Lightweight for Maximum Portability Weighs Only 5.2 kg (11.5 lbs)**

The Sony/Tek 318 and 338 Logic Analyzers bring an unprecedented combination of performance, portability and low price to the field of digital test instrumentation.

Weighing only 5.2 kg (11.5 lb) each, these instruments incorporate proprietary LSI circuitry to provide an array of features usually associated with much larger logic analyzers. Both the 318 and 338 include parallel and serial data acquisition capabilities to cover the widest possible range of applications. For software work, there is powerful multilevel triggering to capture complex real-time code execution. Each instrument can also be remotely controlled through an RS-232 interface, an extremely useful feature in first-line service applications. Also, nonvolatile memory allows both setup information and reference data to be retained and transported from site to site.

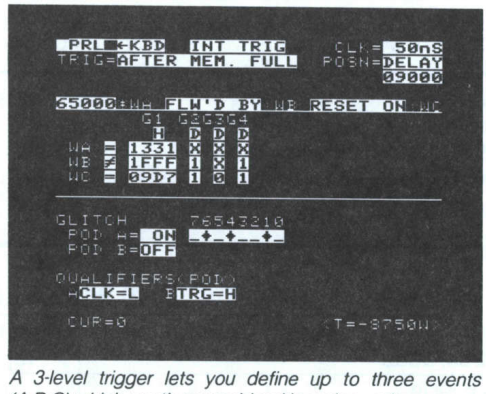
The 318 and 338 Logic Analyzers are both built around the same basic feature set. The difference between the two instruments is in maximum data width and acquisition speed. The 338, which is targeted more toward software applications, allows 32 channels of data acquisition at speeds up to 20 MHz. The 318, which is directed toward hardware applications, permits 16 channels of data acquisition at speeds up to 50 MHz.

Aside from these width/speed differences, the 318 and 338 pack the same powerful features into a highly portable instrument. The basic 318/338 includes parallel state and timing acquisition, with acquisition, reference and glitch memories.

The S1 configuration adds serial acquisition, an RS-232 remote control interface, and nonvolatile memory.

### Parallel State Acquisition

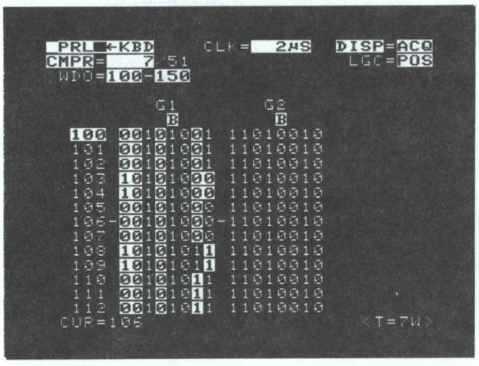
For either software or timing applications, the 318/338 contains a powerful 3-level trigger which allows the capture of complex event sequences as executed by the hardware under test.




*A 3-level trigger lets you define up to three events (A,B,C) which are then combined by using various operators to form the trigger sequence.*

This trigger allows definition of three separate logic events which can be combined through a series of operators to specify the actual trigger sequence. Up to 65,000 occurrences can be required for the first event to come true. The next two events can follow immediately (THEN) or later (FOLLOWED BY). Two or three events can be ORed together. The third event can also be used to reset the trigger sequence.

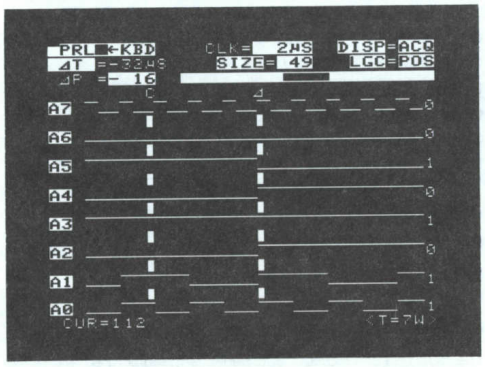
Once acquired, parallel state information can be displayed in binary, hex, octal or decimal radix. The data can be searched for each occurrence of a specified word, and can also be compared with data stored in the reference memory, with any differences highlighted on the display.




*You can compare the data you have just acquired to a set of data in reference memory. All differences are displayed in reverse video.*

## Parallel Timing Acquisition

For timing applications data can be acquired either synchronously, using the clock of the system under test, or asynchronously, using the 318/338's own internal clock. Up to eight channels of timing data can be displayed at once, and each can be identified through a 2-character label entered by the user. For increased accuracy, there is a "delta" measurement feature which counts and displays the number of sample intervals between two movable cursors. For data acquired asynchronously, the time difference is shown on the screen.

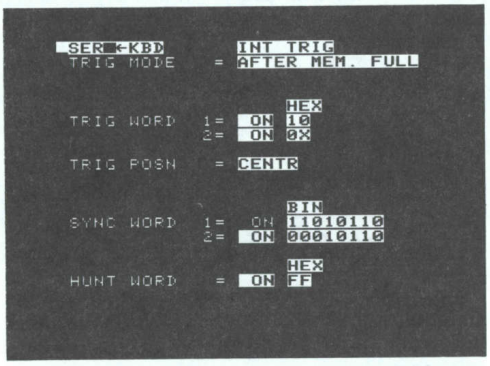



*Timing displays include analysis tools such as measurements between cursors, variable grouping, memory search and glitch display.*

There is also full glitch capture capability. Glitch information is automatically acquired and separately stored any time parallel data is acquired. A separate glitch trigger allows glitch occurrences to be specified on a channel-by-channel basis, with each channel of the glitch trigger ORed with its counterpart in the main trigger.

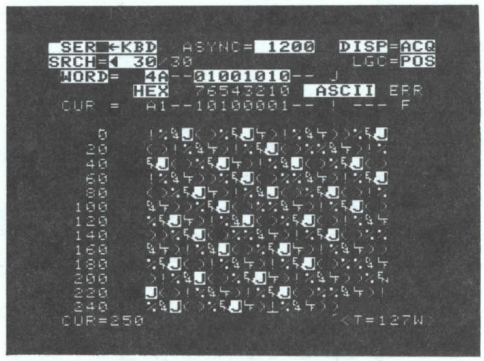
## Serial Data Acquisition

A major part of the S1 configuration package is serial data acquisition, which adds considerable breadth to the instruments' application range. Serial acquisition can take place in either synchronous or asynchronous modes at up to 19200 bits/second, with either 5, 6, 7, 8 or 9 bits per character. For synchronous acquisition, the user can specify sync and hunt words as well as trigger words.




*When defining a serial data acquisition trigger, you can specify sync and hunt words as well as trigger words.*

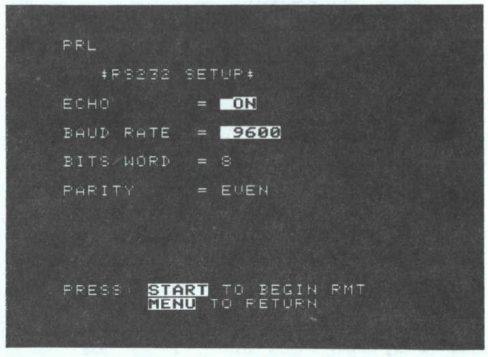
Acquired serial data can be displayed in either state table or character formats. The state table format gives a wide range of radices, including hex, binary, octal, ASCII and EBCDIC. The character format provides 256-character stream displays in either ASCII or EBCDIC. In addition, acquired serial data may be searched for occurrences of a specific word and compared with data stored in reference memory.




*Captured serial data can be displayed in state or character format. Data can also be searched for occurrences of a specified word.*

## RS-232 Interface for Remote Control

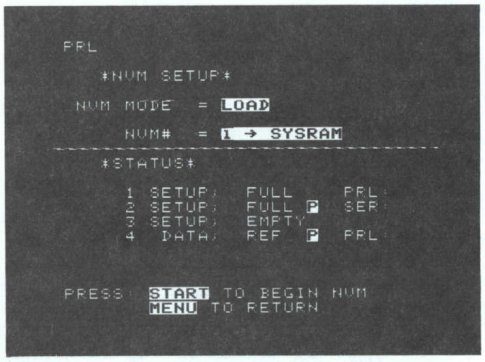
The S1 configuration package includes an RS-232 interface. This allows complete control of the instrument by a remote processor or terminal which can be connected through either a modem or local lines. Consequently, a remote operator can define triggers, acquire data and analyze the results. In addition, the operator can input a reference pattern via a remote terminal. All aspects of the remote connection, such as baud rate, local/remote echo and bits/character, are easily set up through menu prompts supplied by the 318/338.




*Setting up the RS-232 interface is simplified by easy to use menu prompts.*

## Nonvolatile Memory

Also included in the S1 configuration is a nonvolatile memory for storage of instrument setups and data. This memory holds up to three setups (channel configurations, trigger values, and thresholds) and one set of memory data.




*3 Setups and 1 memory (acquisition or reference) can be stored and protected in the nonvolatile memory.*

The nonvolatile memory is useful for rapid restoration of setups and reference data under many conditions. It is especially helpful when using the instrument at a remote service location, where a less skilled technician can quickly configure the instrument to a stored setup with minimal operator intervention.

## CHARACTERISTICS

### PARALLEL ANALYZER FUNCTION

### DATA INPUT

**Channels** — 318: 16 channels; glitch data is detected on all 16 channels. 338: 32 channels; glitch data is detected on 8 channels (POD A).

**Minimum Logic Swing** — 500 mV p-p; centered on threshold voltage.

**Maximum Logic Swing** — Threshold voltage plus 10 V to threshold voltage minus 15 V.

**Glitch Data Width** — 5 ns minimum with 350 mV overdrive from threshold.

**Threshold Voltage** — TTL: +1.4 V. V 1: −10 V to +10 V. V 2: −10 V to +10 V. V 3: = (V 1 +V 2)/2.

### SAMPLING

| External Clock Mode | 318 | 338 |
|---|---|---|
| Data setup time | 13 ns max | 14 ns max |
| Data hold time | 0 ns max | 0 ns max |
| Clock period | 20 ns min | 50 ns min |

**Clock Pulse Width** — High-Logic level: 15 ns min. Low-Logic Level: 15 ns.

**Clock Polarity** — + or −edge.

### INTERNAL CLOCK MODE

**Sample Interval** — 318: 20 ns to 500 ms/sample in 1-2-5 sequence. 338: 50 ns to 500 ms/sample in 1-2-5 sequence.

| Data Memory Depth | 318 | 338 |
|---|---|---|
| Acquisition Memory | 16 x 256 bits | 32 x 256 bits |
| Reference Memory | 16 x 256 bits | 32 x 256 bits |
| Glitch Memory | 16 x 256 bits | 8 x 256 bits |

### TRIGGERING

**Internal Trigger**

**Word Recognizer** — Three words: A, B, and C; selected channels are AND'd together.

**Input** — All data input channels from P6451 data acquisition probes.

**Glitch Trigger** — Selected channels are OR'ed together.

**Trigger Position** — Begin, Center, End, Delay up to 65,000 clock cycles.

**External Trigger**

**Input** — Mini-jack connector on side panel, TTL compatible.

**Threshold** — 1.4 V nominal (TTL level).

**Polarity** — + or −edge.

**Pulse Width** — 20 ns minimum.

**Trigger Output** — Initiated high when an internal trigger sequence, glitch trigger or external trigger is detected. Reset on next acquisition start.

**Output Level** — TTL.

**Current Max** — High-Logic Level: 1 mA. Low-Logic Level: 2 mA.

### DATA DISPLAY

**Timing Diagram Mode** — Maximum of eight channels (one page) present on screen at one time. The 318 has two pages; the 338 has four pages. Glitch Display: Displays glitches on timing diagram as a bit width transition edge. Search: Searches for glitches or user defined word.

**ΔT** — Movable cursor for calculating the number of clocks and temporal distance between two events.

**State Table Mode** — Hex, decimal, octal, or binary radix format. Search: Searches for glitches or user defined word.

Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

### SERIAL STATE ANALYZER FUNCTION

### DATA INPUT

**Data Timing** — Synchronous or asynchronous.

**Bits/Character** — 5, 6, 7, 8 or 9 bits (includes parity bit if parity is active).

### SAMPLING

**Internal Clock for Asynchronous Mode** — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 bits/second.

**External Clock for Both Synchronous and Asynchronous Modes** — Up to 19,200 bits/second.

**Parity Control** — Odd, even, or none.

### TRIGGER SOURCE

Internal or external.

### DATA DISPLAY

**State Table Mode** — Hex, binary, octal, ASCII, EBCDIC radix. Search: Searches for parity errors or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

**Character Table Mode** — All 256 bits of memory displayed in either ASCII or EBCDIC radix. Search: Searches for parity errors or user defined word. Compare: Compares acquisition memory to reference memory and displays mismatched characters in reverse video.

### RS-232 INTERFACE

**Data Transmission Type** — Asynchronous only.

**Communication Mode** — Full Duplex.

**Bits/Character** — Eight bits with parity.

**Parity** — Even.

**Data Transfer Rate** — 110, 150, 300, 600, 1200, 2400, 4800, 9600 BPS.

**Signal Characteristics** — Meets RS-232C standard.

**I/O Connector** — 25 pin standard connector.

### NONVOLATILE MEMORY

**Memory Size** — Three setups (serial or parallel) and one memory acquisition or reference.

**Nonvolatile Period** — Approximately five years at room temperature.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V to 132 V ac, 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width with handle | 237 | 9.3 |
| Height with accessory pouch | 174 | 6.8 |
| Height without accessory pouch | 120 | 4.7 |
| Depth, handle not extended | 409 | 16.1 |
| Depth, handle extended | 492 | 19.4 |
| **Weight** | **kg** | **lb** |
| Net without accessories | 5.1 | 11.5 |
| 318S1 with accessories | 6.7 | 14.7 |
| 338S1 with accessories | 7.2 | 15.7 |

## ORDERING INFORMATION

**318** Logic Analyzer **$5,300**

**Includes:** Power cord (161-0104-00); accessory pouch (016-0697-00); P6107 Probe (1 additional with the S1 configuration) (010-6107-03); P6451 probe, two with the 318, four with the 338 (010-6451-07); workbook; reference guide; operator's manual.

**318S1** Logic Analyzer with Serial Analysis, RS-232 and Nonvolatile Memory **$6,500**

**318F1** Field Installed Serial Analysis, RS-232 and Nonvolatile Memory **$1,500**

**338** Logic Analyzer **$5,800**

**338S1** Logic Analyzer with Serial Analysis, RS-232 and Nonvolatile Memory **$7,000**

**338F1** Field Installed Serial Analysis, RS-232 and Nonvolatile Memory **$1,500**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

## OPTIONAL ACCESSORIES

**Service Manual**

**RS-232 Cable** — Order 012-0757-00 **$140**

**Service Maintenance Kit** — Order 067-1159-01 **$800**

**Null Modem Cable** — Order 012-0530-00 **$75**

The SONY®/TEKTRONIX® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo Japan. Outside of Japan the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.

## 300 SERIES COMPARISON SELECTION GUIDE

| Characteristics | 308 | 318 | 318S1 | 338 | 338S1 |
|---|---|---|---|---|---|
| No. Parallel Data Channels | 8 | 16 | 16 | 32 | 32 |
| Maximum Asynchronous Sample Rate | 20 MHz | 50 MHz | 50 MHz | 20 MHz | 20 MHz |
| Maximum Synchronous Sample Rate | 20 MHz | 50 MHz | 50 MHz | 20 MHz | 20 MHz |
| No Trigger Levels | 1 | 3 | 3 | 3 | 3 |
| Acquisition Memory Depth (Bits/Channel) | 252 | 256 | 256 | 256 | 256 |
| Reference Memory Depth (Bits/Channel) | 252 | 256 | 256 | 256 | 256 |
| Glitch Latch (Channels) | 8 | | | | |
| Glitch Capture (Channels) | No | 16 | 16 | 8 | 8 |
| Glitch Trigger (Channels) | No | 16 | 16 | 8 | 8 |
| Signature Analysis | Yes | No | No | No | No |
| Serial Data Acquisition | Yes | No | Yes | No | Yes |
| RS-232 Remote Control Interface | No | No | Yes | No | Yes |
| Nonvolatile Memory | No | No | Yes | No | Yes |
| Video Output | No | Yes | Yes | Yes | Yes |
| Weight (without accessories) | 8 lb | 11.5 lb | 11.5 lb | 11.5 lb | 11.5 lb |
| Price | $3,950 | $5,300 | $6,500 | $5,800 | $7,000 |

# 308 Data Analyzer

**Four Analyzers in One**

**Up to 25 Channels of Word Recognition Triggering**

**Ultra-Portable**

**Easy to Use**

**Cost Effective**

The 308 is a 20 MHz portable analyzer containing a unique combination of features. It provides timing, state, serial, and signature analysis in an extremely easy-to-use package.

## CHARACTERISTICS

### SIGNAL INPUTS

**Timing and State** — Multi-line probe-tip, eight data lines, one clock and one ground lead.

Maximum Number of Inputs: Eight.

Input Impedance: 1 MΩ, 5 pF.

**Logic Swing** — Minimum: 500 mV +2% of threshold voltage, p-p, centered on threshold voltage.

Maximum: Threshold +10 V to Threshold −15 V.

Maximum Nondestruct Input Voltage: ±40 V.

Width of Data Input: 10 ns minimum with 400 mV overdrive from threshold voltage.

**Threshold Voltage** — TTL: +1.4 V ±0.2 V. Variable: −12 V to +12 V.

Input Mode: Selectable sample or latch (to 5 ns with 550 mV overdrive voltage).

**Serial** — Single Channel Probe Input: 10 MΩ, 13 pF input impedance. 500 V maximum nondestructive input voltage at probe tip. 250 V peak at BNC input connector. Logic Swing: 500 mV minimum plus 2% of threshold voltage, p-p, centered about the threshold. ±30 V maximum. Selectable Parity: ODD, EVEN or NONE. Selectable Bits Per Character: 5, 6, 7 or 8 bits (includes parity if active). Selectable Input Logic: Positive or negative (at probe tip). Synchronizing Word (Synchronous Mode Only): Programmable to require two equal words. If not programmed, defaults to ASCII word SYN. Hunt Word (Synchronous Mode Only): Programmable to require one word. If not programmed, defaults to "XXXXXXXX" (not defined). One Hunt word is equal to three hexadecimal "FF's" (line idles). Stop Bits (Asynchronous Mode Only): Responds to one or more bits.

**Signature Analyzer** — Single Channel Data Input Via Probe: 10 MΩ, 13 pF clock start and stop inputs provided by data acquisition probe.

### CLOCK

**Timing and State** — External Clock: 50 ns minimum period. 24.5 ns high-logic level minimum pulse width. 24.5 ns low-logic level minimum pulse width. 25 ns minimum data setup time. 0 ns minimum data hold time. Internal Clock: 20 MHz sample interval (50 ns minimum). Data pulse width of one sample interval +10 ns required to insure sampling minimum. Sample intervals of 50 ns to 200 ms/sample in 1, 2, 5 sequence. Qualifier Input: Selectable trigger or clock. +1.4 V ±0.2 V TTL input threshold. −5 V to +10 V maximum input voltage.

**Serial** — Synchronous or Asynchronous. Internal Clock for Asynchronous Mode Selectable Via Keyboard: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, and 9600 bits/second (baud rate). Internal Clock Accuracy: ±0.02%. External Clock for Asynchronous Mode: Up to 9600 baud. External Clock for Synchronous Mode: Up to 9600 baud.

### MEMORY

**Data Acquisition Memory** — 8 x 252 bits.

**Reference Memory** — 8 x 252 bits.

**Triggering (State and Timing)** — Synchronous or asynchronous. External qualifier. Data Word Recognizer: Eight channels, programmable in hex, binary, octal, or decimal. External Word Recognizer Probe: 16 channels, programmable in hex, binary, octal, or decimal. Input Threshold: +1.4 V ±0.2 V TTL. Word Recognizer Out: +1.4 V ±0.2 V TTL. Trigger Delay: Programmable from 0 to 65,535 clock cycles. Data Position: Pretrigger or posttrigger selectable. First trigger mode (internal select).

**Triggering (Serial)** — Data Word Recognizer: Programmable to require a sequence of two words (or characters). External Trigger: Programmable for one bit (0 or 1). Trigger Delay: Programmable from 0 to 65,535 by word count (character). Data Position: Pretrigger or posttrigger selectable. Framing Error Detection: Data acquisition is stopped when a valid stop bit is not detected.

### DISPLAY

Status information of the 308 is always displayed at the top of the screen. The menu is displayed with all fields visible. In serial mode, an extended menu is provided for additional serial capabilities.

**Timing Diagram** — Programmable memory window size. Cursor position pointer and word decode. Positive or negative logic display.

**State Table** — Simultaneous display of hex, binary, and octal. 12 word display table. Search Mode: Inverse video highlighting. Compare Mode: Inverse video highlighting of differences. Positive or negative logic display.

**Serial** — Simultaneous display of hex, binary, and ASCII. 12 word character display. Search Mode: Inverse video display of word. Compare Mode: Inverse video display of differences. Positive or negative logic display.

**Signature** — Displays the selects for clock, start, and stop. Displays each signature simultaneously. Displays a four digit signature. Displays Character: 0 to 9, A, C, F, H, P, U.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 237 | 9.3 |
| Height | 117 | 4.6 |
| Depth | 359 | 13.9 |
| **Weight** | **kg** | **lb** |
| Net without probes | 3.7 | 8.0 |
| Net with probes | 4.5 | 10.0 |

### POWER REQUIREMENTS

**Line Voltage** — 90 V to 132 V ac, 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 40 W maximum.

**Temperature Range** — 0°C to +50°C, operating.

## ORDERING INFORMATION

**308** Data Analyzer **$3,950**

**Includes:** Power cord (161-0104-00); accessory pouch (010-0654-00); P6451 probe (016-6451-05); P6107 probe (010-6107-03); operator's manual, maintenance manual.

**OPTIONS**

**Option 01** — P6406 Word Recognizer Probe. **+$420**

**Option 03** — Extended Signature Analysis Capability (Includes P6406 Word Recognizer Probe.) **+$1,950**

**1105** Battery Power Supply **$1,650**

**Option 01** — 230 V Operation. **NC**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

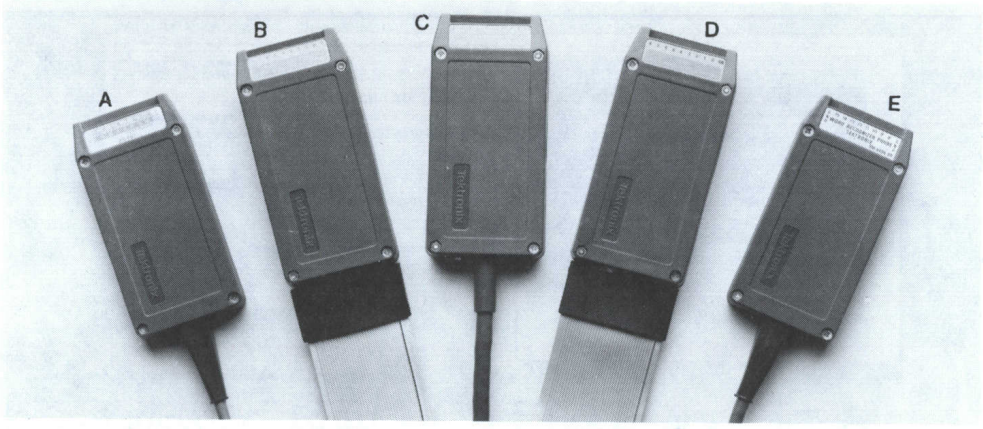
**Option A2** — UK, 240 V/13 A, 50 Hz.

**Option A3** — Australian, 240 V/10 A, 50 Hz.

**Option A4** — North American 240 V/15 A, 60 Hz.

**Option A5** — Switzerland 220 V/10 A, 50 Hz.

The Sony®/Tektronix® 300 Series is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 300 Series is available from Tektronix, Inc., its marketing subsidiaries and distributors.




**A. P6451 8-Channel Data Acquisition Probe** — For use with 7D01, 7D01F, 7D01F2 and 7D02 Option 01.
Order P6451 (010-6451-03) **$545**

**P6451** — For use with 300 Series instruments (right-angle connector to analyzer).
Order P6451 (010-6451-07) **$545**

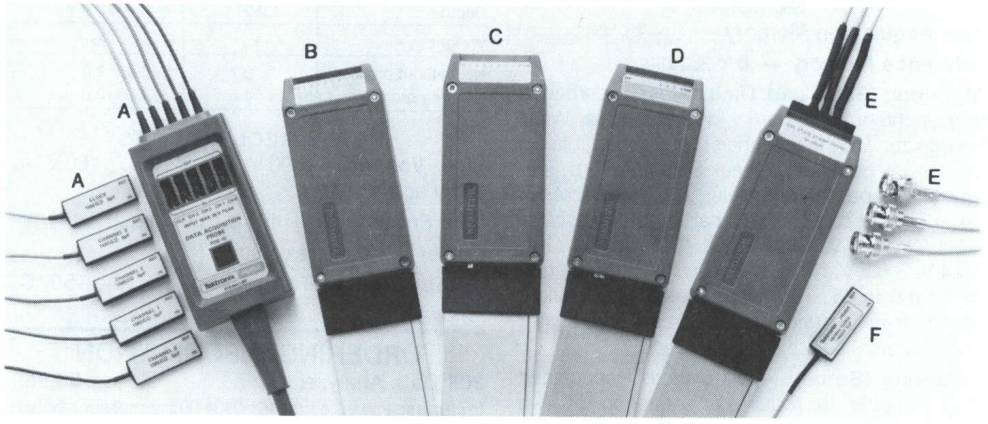
**B. P6452 8-Channel Data Acquisition Probe** — For use with DAS 9100 mainframes, DAS 91A32 modules, and DAS 91A08 modules. Order P6452 **$730**

**C. P6460 8/9-Channel Data Acquisition Probe** — For use with 1240D1, 1240D2, DAS 91A24 and 91AE24 modules. Order P6460 **$700**

**D. P6462 8/9-Channel TTL Only Data Acquisition Probe** — For use with 1240D2, DAS 91A24 DAS 91AE24 and DAS 91A32 modules. Order P6462 **$340**

**E. P6406 16-Channel Word Recognizer Probe** — Replacement for SONY®/TEKTRONIX® 308 Option 01 only.
Order P6406 (010-6406-01) **$570**

**All Probes include lead sets.**




**A. P6453 4-Channel Data Acquisition Probe** — High-speed probe for DAS 91A04A and DAS 91AE04A. Order P6453 **$1,560**

**B. P6455 TTL/MOS Pattern Generator Probe 8-Channels** — For use with DAS 91P16 and DAS 91P32 modules.
Order P6455 **$575**

**C. P6456 ECL Pattern Generator Probe 8-Channels** — For use with DAS 91P16 and DAS 91P32 modules.Order P6456 **$575**

**D. P6457 TTL/MOS Pattern Generator Probe, 4-Channels, Individually Tri-Stateable** — For use with DAS 91P16 and DAS 91P32 modules. Order P6457 **$575**

**E. State Stamp Probe** — For use with DAS 9100 system in Digital Design Lab (DDL) Configuration. Order 021-0366-01 **$1,200**

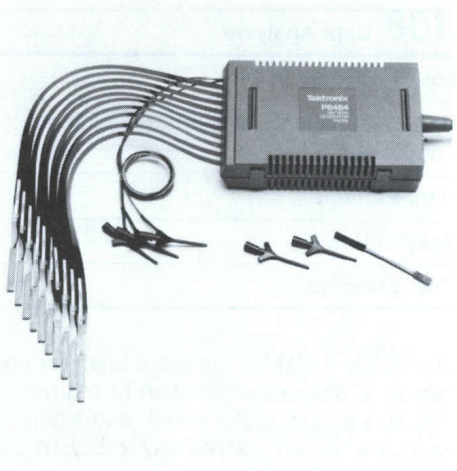
**F. P6454 100 MHz Clock Probe** — For use with DAS 91A08 module (max of one P6454 per DAS system). Order P6454 **$265**

**All probes include lead sets.**

## PROBE APPLICATION MATRIX

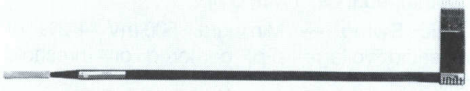
| PRODUCT | P6451 | P6452 | P6453 | P6454 | P6455 | P6456 | P6457 | P6460 | P6462 | P6464 |
|---|---|---|---|---|---|---|---|---|---|---|
| 91A24, 91AE24 | | | | | | | | ✓ | ✓ | |
| 91A32 | | ✓ | | | | | | | ✓ | |
| 91A08 | | ✓ | | ✓ | | | | | | |
| 91A04A, 91AE04A | | | ✓ | | | | | | | |
| 91P16, 91P32 | | | | | ✓ | ✓ | ✓ | | | |
| 91S16, 91S32 | | | | | | | | | | ✓ |
| 1240D1 | | | | | | | | ✓ | | |
| 1240D2 | | | | | | | | ✓ | ✓ | |
| 338, 318, 308 | ✓ | | | | | | | | | |

F

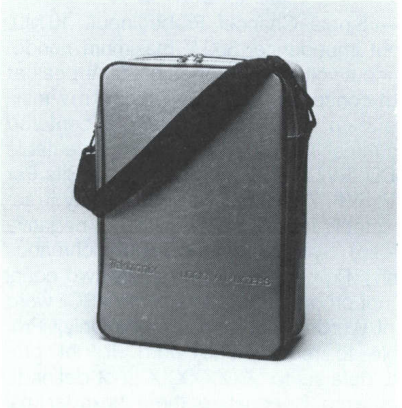


**F. P6464 50 MHz Pattern Generator Probe** — For use with DAS 91S16 and 91S32 modules. Order P6464 **$1,350**

G



**G. Controlled-Width Probelet** — Use with 91S16/91S32 to create programmable pulses. Requires two P6464 channels to create one programmable channel.
Order 020-1392-00 **$150**



**Accessory Pouch** — Convenient for carrying manuals, and other accessories for 1240/1241 and DAS 9100 logic analyzers.
Order 016-0707-00 **$60**

## OPTIONAL ACCESSORIES

**A. Individual Hook Tip Lead Set** — 10 leads, 16 inch, color coded with E-Z Micro Hook Tips. Order 012-0670-00 **$65**

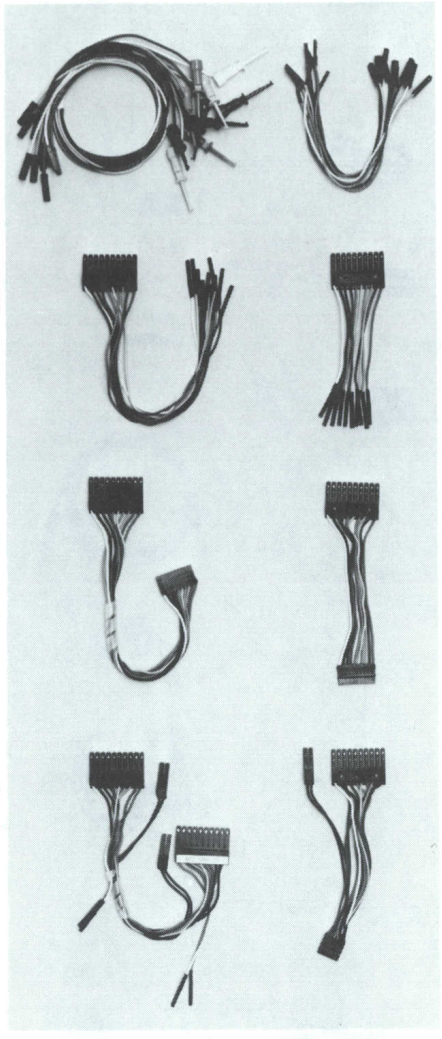
**B. Flying Lead Set** — 10 wide comb, 10 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0747-00 **$50**

**C. Harmonica Lead Set** — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded. Order 012-0800-00 **$30**

**D. Diagnostic Lead Set, DAS 9100** — 10 wide comb to 10 wide comb, and two wide ground jumper, 10 inch, for connecting pattern generator probes to data acquisition probes. Order 012-1000-00 **$75**

**E. Pattern Generator Lead Set** — 10 + 2 wide comb, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included. Used with P6455, P6456, P6457 pattern generator probes. Order 012-0926-00 **$150**

**F. High Speed Pattern Generator Lead Set** — 10 + 2 wide comb to 20 position double row connector, for 0.025 inch square pins on 0.15 inch centers, 5 inch, color coded. Used with P6455, P6456, P6457 pattern generator probes. Order 012-0551-00 **$110**




**G. Individual Lead Set** — 10 leads, 8 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0655-02 **$100**

* **Individual Lead Set** — 10 leads, 16 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0655-01 **$100**

**H. Flying Lead Set** — 10 wide comb, 5 inch, color coded, connects to 0.025 inch square pins, grabber tips not included. Order 012-0987-00 **$45**

**I. Harmonica Lead Set** — 10 wide comb to 10 position single row connector, for 0.025 inch square pins on 0.1 inch centers, 5 inch, color coded. Order 012-0968-00 **$100**

**J. Diagnostic Lead Set, 1240/1241** — 10 wide comb with 2 wide ground to 12 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 10 inch, color coded. Order 012-0556-00 **$50**

**K. Pattern Generator Lead Set** — 10 + 6 wide comb with VH and VL Pomona Hook Tips, 9 inch, twisted pairs, color coded, connects to 0.025 inch square pins, grabber tips not included. Used with P6455, P6456, P6457 pattern generator probes. Order 012-1053-00 **$110**

**L. GPIB Adaptor** — Two 10 wide combs to IEEE Standard 488 Bus Connector, 10 inch. Order 103-0209-01 **$180**

* *Not shown.*

**A. Low Profile Dip Clip** — 40 pin dip to 40 position double row connector, for 0.025 inch square pins on 0.1 inch centers, 4 inch (requires male adaptor below). Order 015-0339-02 **$44**

* **Low Profile Dip Clip** — 40 pin, same as above except 12 inch. Order 015-0339-00 **$44**

**B. 40 Pin Male Adaptor** — 40 position double row header with 0.025 inch square pins on 0.1 inch centers, interfaces the PM 101 or flying lead sets to low profile dip clip above. Order 380-0560-05 **$15**

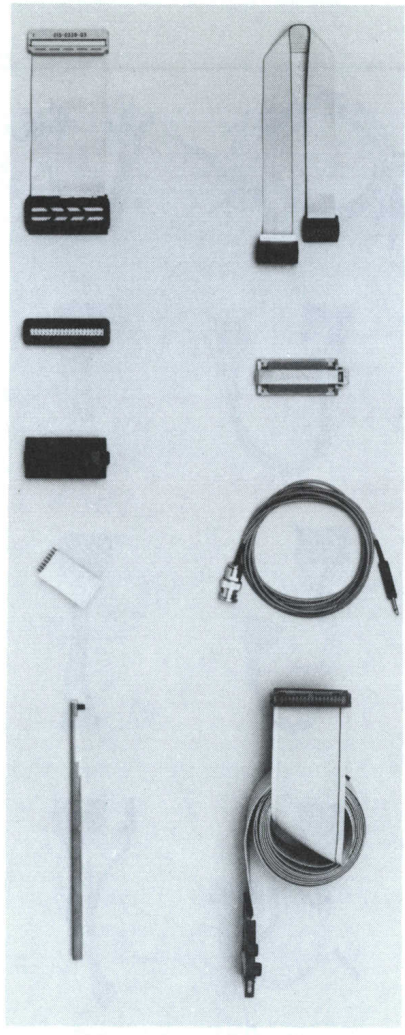
**C. 40 Pin Dip Socket Female Adaptor** — 40 position double row head with 0.025 inch square pins on 0.1 inch centers to 40 pin dip socket, for interfacing 40 pin low profile dip clips to PM 100 series probes. Order 380-0647-01 **$36**

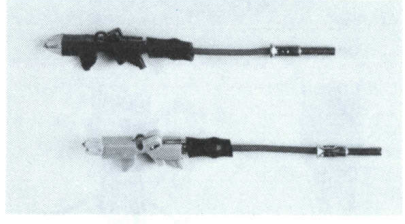
**D. IC Clip** — 16 pin dip, clothes pin style. Order 003-0709-00 **$11.75**

* **IC Clip** — 24 pin dip, clothes pin style. Order 003-0823-00 **$30**

* **IC Clip** — 40 pin dip, clothes pin style. Order 003-0801-00 **$43**

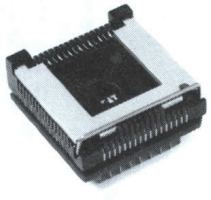
**E. Circuit Board Ejector Tool** — for removing DAS 9100 module cards. Order 214-3154-00 **$5.75**



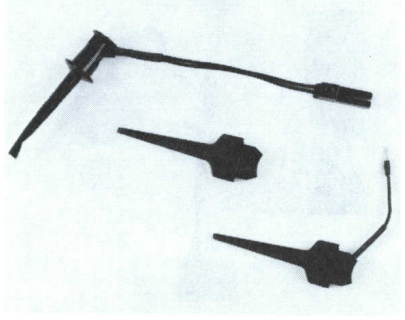

**F. High Speed Grippers** — Package of ten, 1.75 inch, for Dip packages with 0.1 inch lead spacing, use with P6453 or P6454. Order 195-2234-06 **$190**

* **High Speed Lead Connectors** — Package of ten, gold plated contact pins that interface to podlet lead receptacles on P6453 or P6454. Order 131-2729-02 **$30**




**G. Sense Leads** — Package of ten, 2 wide comb to Pomona Hook Tip, 5 inch, black for ground or VL. Order 012-0989-01 **$110**

* **Sense Leads** — Package of ten, 2 wide comb to Pomona Hook Tip, 5 inch, green for ground or VH. Order 012-0990-01 **$110**




* *Not Shown.*




**H. Low Profile Dip Clip** — 16 pin dip to 16 position double row header with 0.025 inch square pins on 0.1 inch centers, 12 inch. Order 015-0330-00 **$40**

**I. Flat Cable Mounts** — Adhesive Back for securing and organizing probes with flat ribbon cables. Order 343-1048-00 **$0.95**

**J. Sync Out Cable** — Miniature Phone Plug to BNC, 79 inch, for 91A24 sync output. Order 175-8165-00 **$35**

* **91AE24 Jumper Cable Replacements** — Package of seven, twisted pair, 2 position connectors, 3 inch. Order 175-8167-00 **$4.80**

**K. Probe Extender Cable** — Male to Female 34 position double row connectors compatible with P6452, P6460, P6462, 6 feet. Not for use on 91A24 or 91AE24. Order 012-1012-01 **$110**




**L. High Speed Grippers** — Package of ten, 1.75 inch, for flat packages with 0.05 inch lead spacing, use with P6453 or P6454. Order 195-1943-06 **$190**

* **91AE04A Coaxial Jumper Cables Replacements** — 3 inch, SMA connectors to connect 91A04A to 91AE04A. Order 175-6425-00 **$18.50**

**O. LCC (Leadless Chip Carrier) to PGA (Pin Grid Array) Adapter** — 68 pin package, for adapting 80286 (LCC) packages to 80286 (PGA) package. To Order 015-0494-00 contact your local sales office.

**M. Grabber Tip** — Package of 12, for general purpose probing with various lead sets. Order 020-0720-00 **$40**

**N. High Speed Clock Lead** — With grabber tip, package of two, for use with P6453 or P6454. Order 195-3659-00 **$15**

**UPIK 40, Universal Probe Interface Kit** — For 40 pin dip packages. Allows user to configure interconnect from 6 probes or less to a clothes pin style 40 pin IC clip. Order UPIK 40 **$175**

* **RS-232 Cable** — Male-to-female, 20 inch, wires: 1-1, 2-2, 3-3, 4-4, 5-5, 6-6, 7-7, 8-8, 11-11, 12-12, 15-15, 17-17, 19-19, 20-20, 22-22. Used with 1200C01 modem interface or DAS 9100 line printer and communications interface. Order 012-0911-00 **$85**

* **RS-232 Cable** — Male-to-female, 2 meter, 25 wires: 1-1, 2-2, 3-3, thru 25-25. General purpose. Order 012-0815-00 **$55**

* **Null Modem Cable** — Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-5, 5-4, 7-7, 8-20, 11-11, 12-12, 19-19, 20-8. General purpose. Order 012-0820-00 **$85**

* **Null Modem Cable** — Female-to-female, 60 inch, wires: 1-1, 2-3, 3-2, 4-8, 5-8, 6-20, 7-7, 8-4, 8-5, 20-6. Used with 1200C01 Serial Printer interface. Order 012-0530-00 **$75**

* **Parallel Interface Cable** — Two meter, used with 1200C11 Parallel Printer COMM Pack for Centronix type printer interface. Order 012-0997-00 **$55**

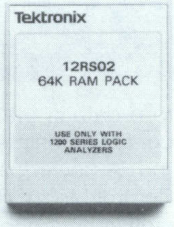
* **GPIB Cable** — Two meter. Order 012-0630-01 **$75**

* **75 Ω Coaxial Cable** — BNC to BNC, 42 inch, used with video hard copy interface. Order 012-0074-00 **$17.50**

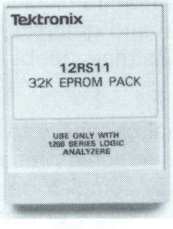
* **75 Ω Coaxial Cable** — BNC to BNC, 120 inch, used with video hard copy interface. Order 175-2753-00 **$23**

A

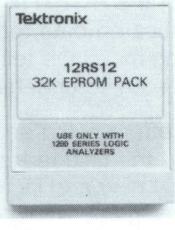
C




B




D



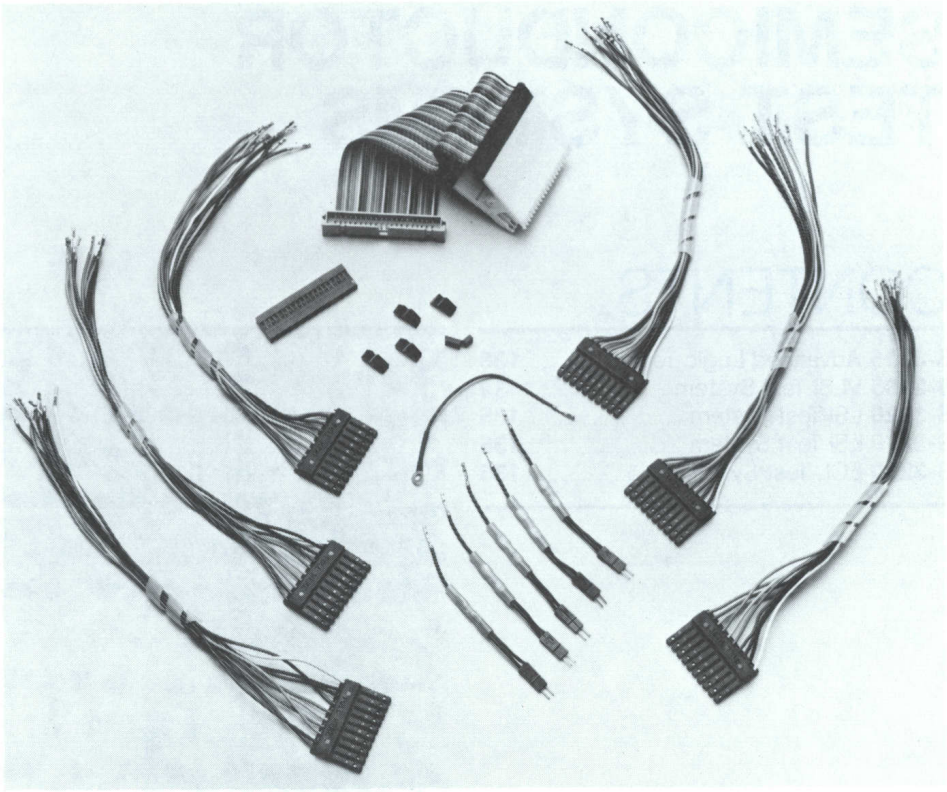

**A. 8 k RAM Pack** — With lithium iodide battery back up, used with 1240/1241. Order 12RS01 **$300**

**B. 32 k EPROM Pack** — Used with 1240/1241, EPROMs not included. Order 12RS11 **$85**

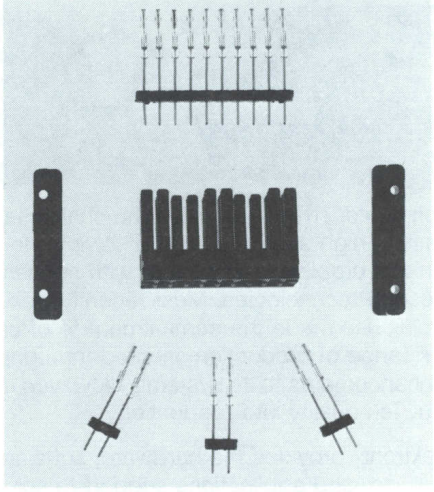
**C. 64 k RAM Pack** — Lithium iodide battery backup, used with 1240/1241. Order 12RS02 **$500**

**D. 32 k EPROM Pack** — Used with 1240/1241, four 68764 or 68766 EPROMs included. Order 12RS12 **$300**

UPIK 40



E



**E. Circuit Board Mounted Probe Connector Kit** — 10 + 6 wide comb to 0.025 inch square pins on 0.15 inch centers, with mounting tabs, for PC mounting, mounting hole dimensions 0.80 inch wide X0.95 inch long. Interfaces to the following probes: P6452, P6455, P6456, P6457, P6460, and P6462. Seven piece kit. Order 020-1027-00 **$35**

* **DAS 9100 Service Maintenance Kit** — Includes board and cable extenders for DAS modules, power supplies, CRT, and keyboard. Order 067-0980-01 **$1,250**

* **DAS 9100 Setup and Hold Time Test Fixture** — Order 067-1037-00 **$1,200**

* **DAS 9100 High Speed Acquisition Test Fixture** — For verification of DAS 91A04, DAS 91AE04, DAS 91A04A, and DAS 91AE04A modules. Order 067-1139-00 **$250**

F

**F. Tape Cartridges, DC 100 Type** — Package of five used on DAS 9100 Option 01. Order 119-1350-01 **$120**

* **Mnemonic Conversion Tape, DAS 9100** — Converts mnemonic and all type files from DAS firmware versions 1.05 and 1.07 to compatability with DAS firmware versions 1.09 or 1.11. Order 062-6705-00 **$75**

**RECOMMENDED CARTS For 1240/1241 and DAS 9100**

* **K117 Instrument Shuttle** — See page 423 for complete description. **$265**

* **K212 Cart** — See page 423 for complete description. **$495**

* **Tilt Bail** — For DAS 9100. Order 348-0727-01 **$31**

* **Rackmount Kit** — For DAS 9100. Order 016-0463-00 **$200**

* **Rackmount Kit** — For 1240/1241. Order 016-0789-00 **$400**

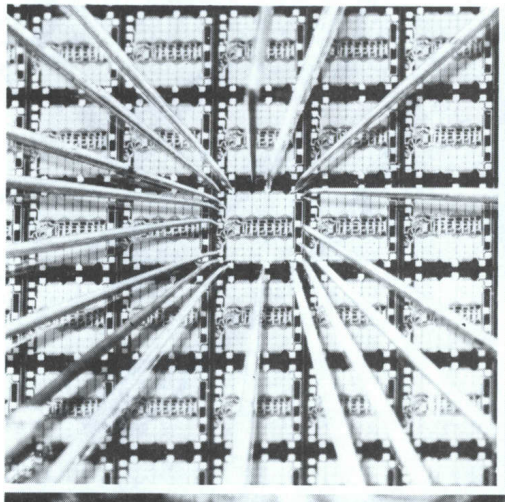


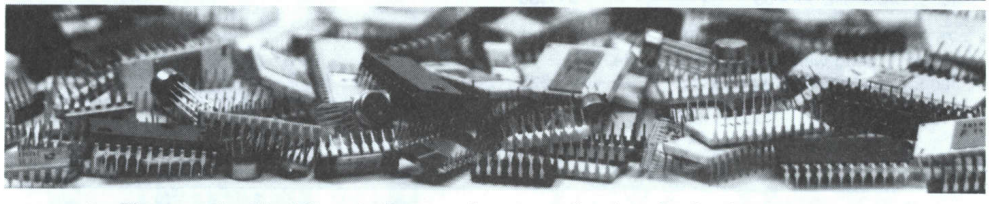
** Not shown.*

# SEMICONDUCTOR TEST SYSTEMS

## CONTENTS

**S-3225** Advanced Logic Tester ..... **133**
**S-3295** VLSI Test System ..... **134**
**S-3220** LSI Test System ..... **135**
**S-3270** LSI Test System ..... **135**
**S-3280** ECL Test System ..... **135**







Tektronix semiconductor test systems are known throughout the electronics industry for their innovative solutions to the latest testing challenges. The S-3200 Series LSI and VLSI test systems have become a key element in engineering and production test facilities throughout the world. Each successive generation of semiconductor devices boasts higher speed, more pins, more functions per chip and more complex testing requirements. Tektronix S-3200 Series systems have met the advancing demands of semiconductor technology with corresponding advances in test capability—features like single-shot time measurement, variable risetime drivers, and powerful data reduction software packages.

Marking the beginning of Tektronix' state-of-the-art test technology development, our first generation automated semiconductor tester, the S-3260, was designed to characterize and test the largest LSI devices in use at the time (four and eight-bit microprocessors, 1 k memories, and peripheral chips). Subsequent systems provided improved device characterization and were designed for quality control in production test environments. Then we tackled the challenge of testing high speed logic and solving the unique problems associated with subnanosecond technologies. Most recently, Tektronix has made the commitment to offer a full range of production-oriented throughput enhancements to its systems. Now, you can put Tek quality into production.

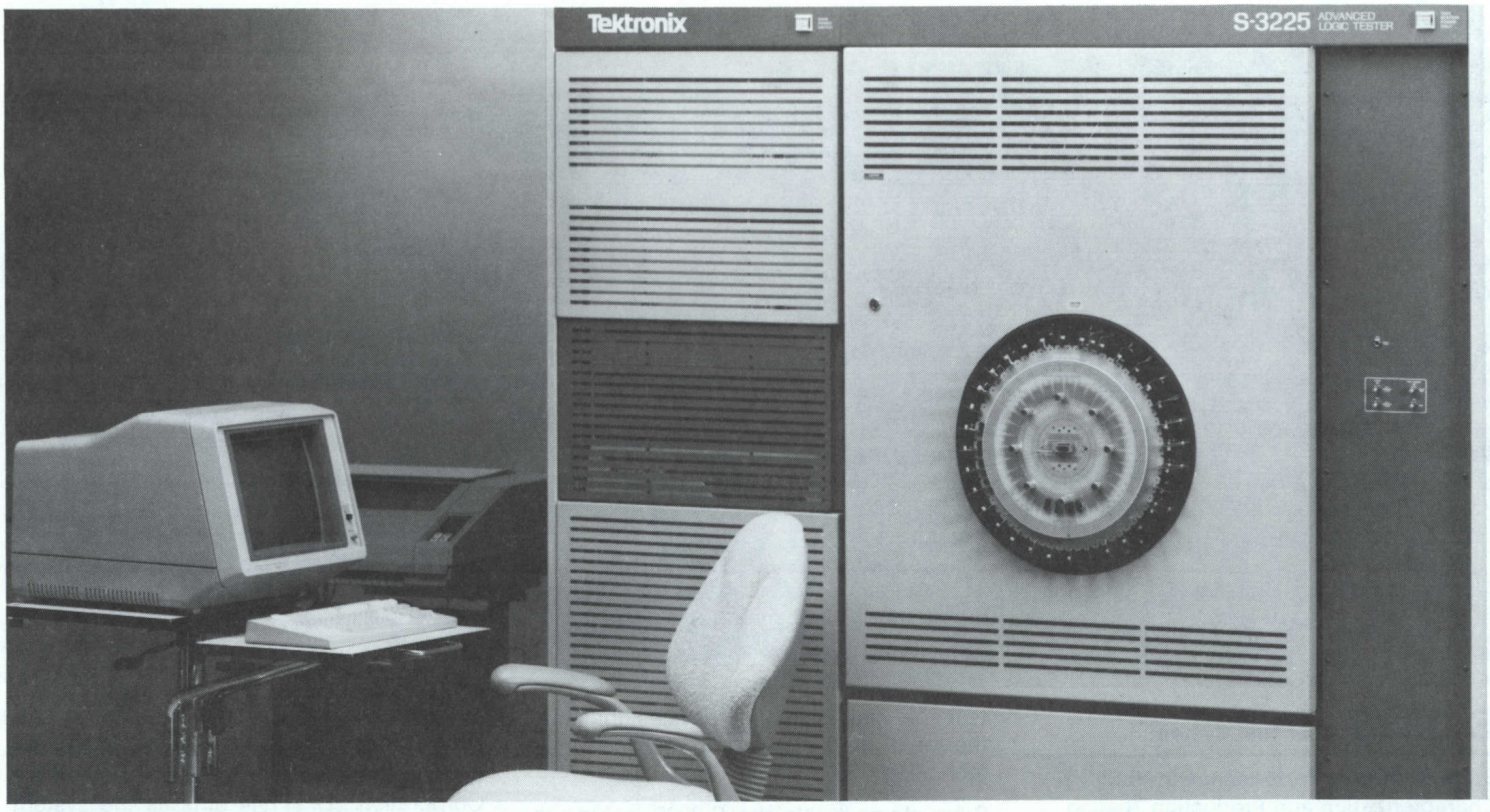
Tektronix provides the hardware, software, training, and applications support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources, not as insurmountable problems. The field-proven hardware and software in every S-3200 system provides the versatility to get the job done.

Every S-3200 system uses the same highly advanced software—TEKTEST®. So there's only one language to learn. Using TEKTEST, a test engineer can easily and quickly generate and debug programs for device testing or characterization and then transfer these programs from one system to another. And, using our foreground/background capability, up to four users can program or compile data in the background while testing continues uninterrupted in the foreground. A powerful debugging tool, Terminal Control Mode, gives the test engineer interactive control of the test program.

All of the S-3200 systems feature highly sophisticated data reduction and graphics, which make the test results manageable and easy to understand.

We offer analog and digital capability to meet the unique test requirements presented by new and increasingly complex devices. In fact, most manufacturers of captive devices use Tektronix systems for just this reason. Tektronix is also a device manufacturer and has been testing its own ICs and hybrids for years. We have developed expertise and in-depth understanding of complex testing.

At Tektronix, we've built on our past experience and knowledge about device testing to create a total, compatible line of LSI/VLSI test systems that can help solve your test problems — today and in the future.




# S-3225 Advanced Logic Tester

**Specifically Designed for Advanced Schottky-TTL and HCMOS Technologies**

**High Speed Driver Features 1 V/ns Slew Rate**

**Seven-Phase Programmable Clock with 125 ps Edge Placement**

**External Fixturing Site Offers a High-Fidelity Interface Point for Handlers and Probers**

The S-3225 Advanced Logic Tester is a production test system designed to provide the full range of capabilities required for thorough Advanced Schottky TTL and High Speed CMOS device testing. This versatile system encourages a test strategy based on accurate and exhaustive production testing, in the belief that superior accuracy produces higher yields. The S-3225 can perform thorough device tests that eliminate the risk of passing marginal parts while ensuring that all passing devices meet very tight guardband tolerances. Although the S-3225 is aimed at high-throughput applications, such as production QC and receiving inspection, its high performance meets the stringent demands of the engineering characterization lab.

The standard system package consists of a vertical test station mated to an integral rack bay that houses the system controller and stimulus equipment. The "carousel" within the test station accommodates up to 64 D25 Pin Electronics Cards, each supporting a single DUT I/O pin. The new D25 is the "front end" of the S-3225, since it interfaces directly to the DUT and provides the exacting electrical performance required by the emerging families of high-speed logic—AS-TTL and HCMOS. The D25's high slew rate (greater than 1 V/ns) and its wide dynamic range (−2 V to +8 V programmable range) are capabilities essential to meaningful testing of high-speed devices.

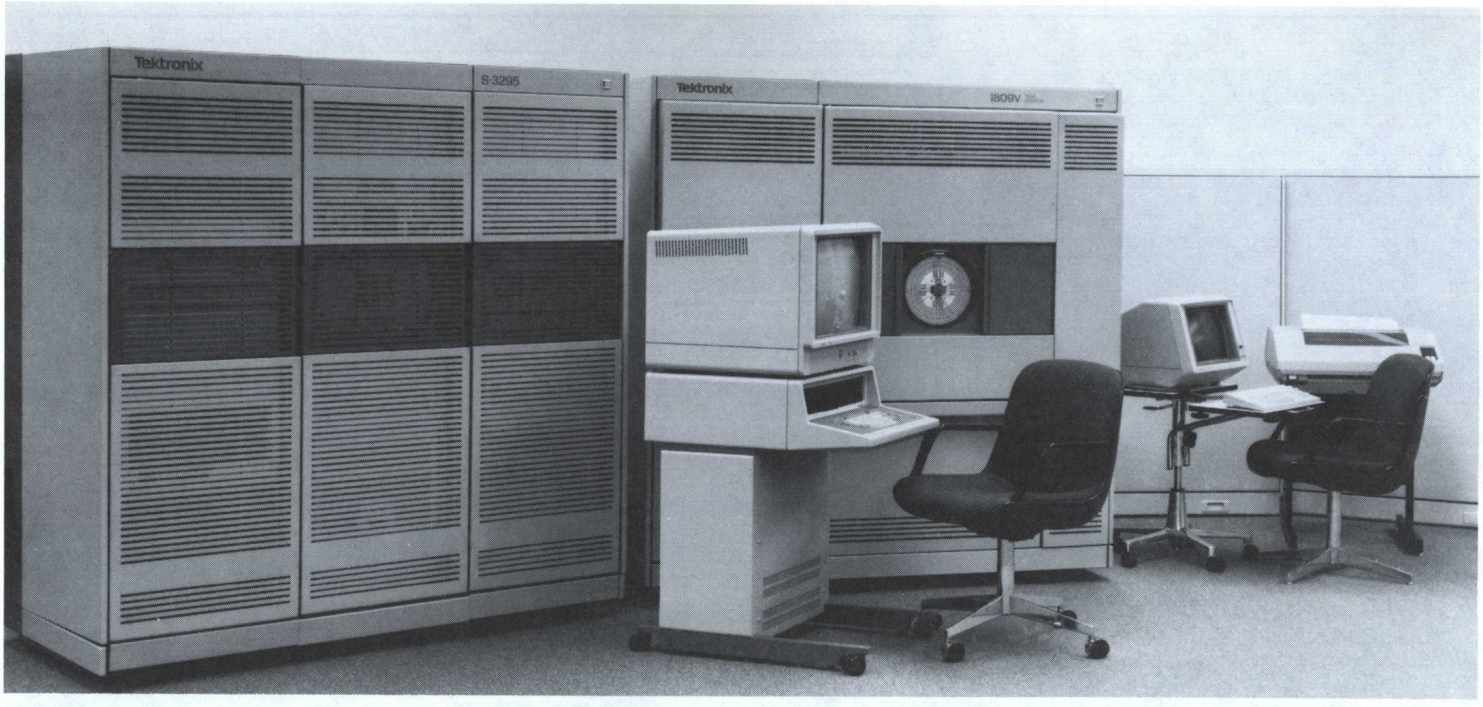
The system's seven-phase (14 phases optional) timing generator has 125 ps edge placement programming increments, placing the S-3225 at the top of its class in timing accuracy. Other standard features yield not only accuracy, but also outstanding throughput performance. The Parallel Parametric Unit, for example, implements dc measurements on all DUT pins simultaneously. And the Single-Shot Time Measurement System allows ac measurements such as *propagation delay*, *access time*, and *setup/hold time* to be made in a single pass, saving time-consuming "iterated-strobe" measurement steps while enhancing accuracy (the resolution of measurements made with the S-STMS is 50 ps).

Special provisions for efficient interfacing to automatic device handlers and wafer probers are fundamental to the S-3225's production test capability. The system has a production-optimized *External Fixturing Site* that allows fast and easy fixturing changeovers and preserves the integrity of the critical driver/comparator signal path. This is accomplished by extending the controlled-impedance portion of that path outside the system housing, so that it directly mates various automated device handlers. Interface cabling to these external devices is minimized or eliminated. Conventional (horizontally-oriented) wafer probers that require a cable interface to the S-3225 also benefit from the systems' ability to provide full-spec driver/comparator performance into cable interfaces as long as 18 inches.

For those applications requiring full clock rate device testing at speeds up to 300 MHz, the Fmax Test Option furnishes a separate, high-quality 50 ohm path to route signals to and from external GPIB-controlled instrumentation. This path is used to connect chosen DUT pins to pulse generators, counters, and sampling equipment to allow those pins to be monitored at their full functional speed. The Fmax Test Option is another unique attribute that makes the S-3225 a superior production test system.

The S-3225 uses the familiar TEKTEST III Operating System/Test Language that provides self explanatory high-level test constructs, enabling users to come quickly "up to speed" with their device test programming skills. Of course, programs written in TEKTEST III can be transported easily between all Tektronix S-3200 Series systems, with only minor hardware-related modifications required for most application.

With speed and accuracy that meet the challenge of the fastest Advanced Schottky-TTL and High Speed CMOS devices, and high-throughput features for volume testing, the S-3225 has the right mix of features for a tough testing job. From any perspective, the S-3225 is a unique solution to high-performance production testing.






## S-3295 VLSI Test System

**State-of-the-Art Performance in VLSI Characterization and Production Testing**

**256 Channels, 128 I/O Pins**

**State-of-the-Art Driver/Receiver**

**Programmable Dynamic Loads**

**128 kbit Local Pattern Memory**

**Automatic Deskew**

**DEC PDP-11/44 CPU**

**Dynamic Time-Set Selection**

**Advanced Color Graphics and Data Reduction**

**High Precision Combined with High Throughput for Production Applications**

**TEKTEST V, an RSX-11M Based, Super Enhanced TEKTEST Language and User Interface**

The S-3295 was designed to meet the needs of the user that demands precision, reliability, and efficiency in an automated test system. In applications ranging from the engineering lab to the production test floor, the S-3295 offers a package of features unequaled in the industry. Building on the proven architecture of the S-3200 Series, the S-3295 incorporates significant advances in the areas of real-time pattern generation, timing flexibility/accuracy, resolution, and functional test capability. This system supports up to 256 independent pins (128 I, 128 O), giving it the capacity to test the high pin-count devices that mark the next step forward in semiconductor technology.

Subsystems within the S-3295 include the Pattern Processor, a powerful dedicated pattern computer; the Multi-Set Timing Generator, which provides 16 sets of 16 timing phases, accurate 125 picosecond timing resolution, and split-cycle operation at all clock speeds; and the 1809 V Vertical Test Station that houses the D95 Pin Electronics Cards.

The critical "Device-Under-Test" environment is the foundation upon which an effective testing strategy is built. The S-3295 supports this environment with a pin electronics picture that offers unparalleled versatility and precision. Drawing upon Tektronix' traditional strength in analog design, we have furnished the S-3295 with signal drivers that feature programmable risetime, extremely low inhibit leakage, low aberrations, and wide bandwidth. These drivers are complemented by receivers of comparable performance. The driver/receiver (I/O) pairs are backed up by 128 k of local memory, that can be used as a pattern memory or as an error buffer. The system's 16 clock phases are distributed such that each Dual Pin Electronics Card is fed by 11 phases, meeting the needs of even the most complex digital ICs. Automatic deskew of driver, comparator, and inhibit phases ensures that signal edges will appear in precisely the right relationship. Programmable dynamic output loads eliminate the need for complex external load boards, or alternatively, a 50-ohm resistive load can connect to the DUT output under program control. For testing higher-speed devices, the S-3295 uses a novel multiplexing approach that doubles the effective cycle rate (to 40 MHz) without degrading the signals. A Digital Equipment Corporation PDP-11/44 acts as the system controller and provides up to 4 megabytes of main memory. The user interface to the system and its controller is a Tektronix 4100 Series color graphics terminal. The color display provides enhanced clarity for all types of data plots—bit maps, shmoo plots, yield analyses, etc.

The S-3295's unique features are integrated with several of the standard features of the S-3200 Series. Among these are the Single Shot Time Measurement Subsystem, the 50-ohm analog switching matrix, the optional Waveform Digitizer, and a host of optional OEM stimulus and measurement equipment. In addition, the S-3295 runs the most powerful test software yet—TEKTEST V. This RSX-11M based test language provides an application-oriented instruction set for device testing, combined with the versatile data handling features of the RSX-11M Operating System.

Of particular interest to those testing devices in a production environment, the S-3295 is now available with a series of throughput-enhancing options that make it into a cost-effective production test system. The exceptional accuracy of the S-3295 permits the use of very tight test tolerances, which results in substantially increased yield figures. This yield improvement, combined with the increased volume of devices tested when using such options as the Quad Site Handler Interface, makes the S-3295 a valuable tool in a broad range of production applications.

S-3220

## S-3220 LSI Test System

**Full Capability 20 MHz Test System**

**Cost-Effective for High-Throughput Production Applications**

**Enhanced 1 k Pattern RAM Supplements 4 k per Pin Stored Memory**

**Single-Shot Timing Measurement**

**Uses TEKTEST®, Allowing Device Characterization Programs to be Condensed and Used in Production Testing**

**Up to 128-Pin Test Capability**

The S-3220 is offered as a production-oriented complement to the Tektronix S-3270 Test System. Since the S-3220 uses the TEKTEST control software used in all S-3200 systems, programs originally developed for engineering use can easily be condensed and employed in a high volume production or incoming inspection environment. The essential test related features of the larger systems are retained in the S-3220, allowing (with no loss in speed or accuracy) functional or pattern testing as well as dc parametric and single-pass ac parametric testing.

The S-3220 is configured with a vertical pin-electronics package that is integrated with the control/stimulus equipment rack. This feature eases prober/handler mechanical interface and reduces floor space requirements—an important consideration in most production areas.

S-3270

## S-3270 LSI Test System

**Uninterrupted Error Storage at 20 MHz**

**Multiple Pattern Sources**

**14 Programmable Channels of Timing Information**

**Test Devices with Up to 128 Pins**

**Single-Shot Timing**

The S-3270 system tests LSI, microprocessors, analog and digital hybrids, peripheral interface circuits, RAMs, ROMs, and more. Designed to deliver test results on the devices you see everyday, it is also built to deliver results when new devices appear.

With the S-3270, you can perform functional tests at speeds up to 20 MHz. When you must test a microprocessor at its optimum speed, you need the S-3270.

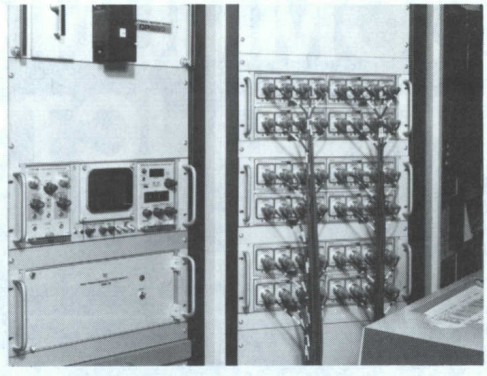
When testing one of the new, fast devices with the S-3270, you will not have to stop the test to log an error. The S-3270 keeps right on testing while it catches the error and records its location. Input/Output switching may also be performed at a clock rate of 20 MHz.

The system has 64 pin-electronic cards, each with input and output capability, so you can test a device with up to 128 pins. The 14-phase clock gives you many programmable channels of timing information, to properly and effectively test devices.

For total flexibility, the S-3270 features independent control of logic level definition at each driver and receiver. You set the logic level on every input and output channel, so you are not bound by the limits of the system.

The unique Single-Shot Time Measurement technique allows you to make a measurement with 50 ps resolution in one iteration. Dynamic measurements can also be made by moving strobes (iteration) or by using the optional waveform digitizer.

S-3280



## S-3280 ECL Test System

**100 k ECL Testing**

**Precision Fixturing**

**Subnanosecond Measurements**

**High-Speed Drivers**

**Sampling for Waveform Analysis**

**CML Capability**

The S-3280 was designed specifically to solve ECL testing problems. Featuring subnanosecond time measurement capability, the high-speed hardware gives the S-3280 the ability to test ECL devices to their fullest.

One of the more important features of an ECL test system is its ability to make accurate timing measurements. The S-3280 features three methods of making dynamic measurements. First, Delta-T provides measurements with 50 ps resolution on any test vector, at 20 MHz data rate, in a single pass. Second, our Waveform Digitizing (sampling) capability provides 1 ps resolution to digitize and store any waveform for further analysis. Third, for functional testing, the system's strobed comparators will make tests on any or all test vectors at 20 MHz. The system features 1 mV programming resolution with dual-level comparators on every channel.

Because no multiplexing is necessary the system uses the shortest possible path to deliver clean, accurate signals to the device, thus minimizing waveform degradation.

The S-3280 will measure the parameters of today's ECL devices and will continue to be able to test the more advanced high-speed logic devices that are being developed. The S-3280's advanced, high-speed measurement characteristics make it a superior ECL testing solution.

# COMMUNICATIONS PRODUCTS

## CONTENTS

Television Products ..... 137
Fiber Optic TDR Cable Testers ..... 150
Communications Network Analyzers ..... 152
Metallic TDR Cable Testers ..... 153
Spectrum Analyzers ..... 154

Communications Products are quality instruments designed to test, time, measure and monitor a variety of television, RF, fiber optic, and data communications network signals.

Electronic communications continue to impact mankind through newer and better equipment and applications. We are proud to be at the leading edge of these new technological opportunities. Here are a few examples:

**Spectrum Analyzers**
The communications industry demands high performance analysis both in the lab and in the field. To meet the demands of the industry we offer the 490 series programmable spectrum analyzers covering baseband frequencies through 325 GHz. See pages 155 to 164.

To meet the demands for system automation and remote site control we offer GRASP, the first in the TEKSPANS family of spectrum analyzer software. GRASP improves the accuracy, repeatability and speed of 490 series spectrum analyzer measurements and supports a variety of popular controllers.

Because of your need for measurement versatility, we offer the 7000 series family of spectrum analyzer plug-ins. These easy-to-use plug-in models cover 20 Hz to 2.5 GHz, with individual ranges appropriate for applications from audio/baseband to microwave measurement. A variety of features let you select the capability you need. They share the versatility that is basic to the Tektronix plug-in concept—there are over 30 other test and measurement plug-ins.

To meet your demand for high performance millimeter applications, we offer the WM 490 series of waveguide mixers. Calibrated amplitude and frequency measurements from 18 GHz to 325 GHz are made possible when coupled with the 490 series spectrum analyzer.

**Television**
Component technology is impacting the television industry. We're developing new products which address the needs in this area. The TSG-300 Component Analog Test Signal Generator is featured on page 139.

Many broadcasters are in the process of turning to multichannel sound. We're meeting some of their new stereo needs with our 1450-1. This high precision demodulator is updated and offers a new wide bandwidth audio section for multichannel sound. See page 146.

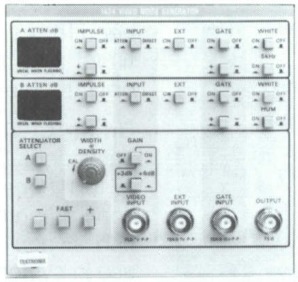
Answering the market's demands for more performance, less cost and user friendly operation, the 1710B Series Waveform Monitor is now available in NTSC and PAL formats. See page 138. In addition, the TSG170A NTSC Sync and Test Signal Generator offers easy to use front panel signal selection, test signal timing and separate sync output timing. See page 139.

**Communication Network Analyzers**
Two new portable data communications analyzers perform analysis at rates up to 19,200 bps in the 835 and 72,000 bps full duplex and 144,000 bps half duplex in the 836. Both products are also available as rackmount configurations. See page 150.

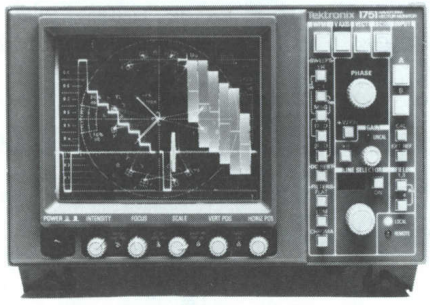
A new fiber optical bandwidth test set automatically measures bandwidth to 1.45 GHz.

For a dual wavelength (switchable) time domain reflectometer, the OF235 performs repeatable, accurate distance and loss measurements on single mode optical fibers at 1300 nm and 1550 nm wavelengths.

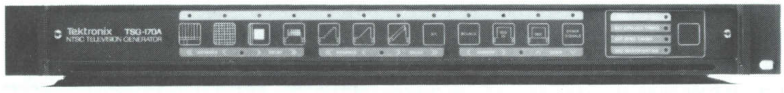
Eleven new fiber adaptors built around the GTE elastomeric splice are available for Tektronix fiber optic test equipment.



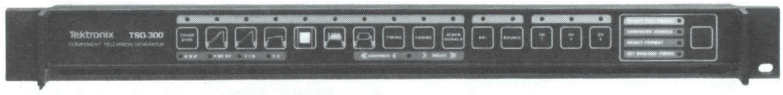
*The NEW 1434 VIDEO NOISE GENERATOR provides signals for evaluation of video equipment noise susceptibility.*



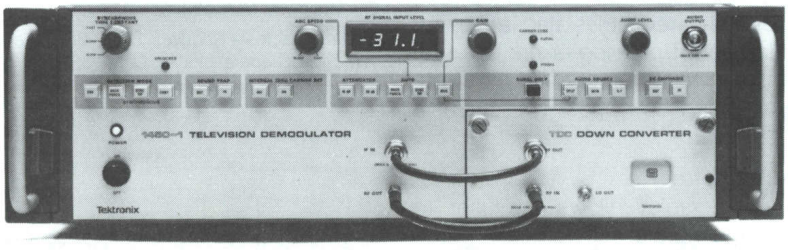
*Simultaneous display and dual filter modes now enhance the 1750 SERIES WAVEFORM/VECTOR MONITOR.*



*Now in a single, compact package. . . the TSG-170A NTSC SYNC AND TEST SIGNAL GENERATOR provides the test signals you need plus a full RS-170A genlock sync generator.*



*The TSG-300 COMPONENT TELEVISION GENERATOR provides direct signal generation in the commonly used component formats.*



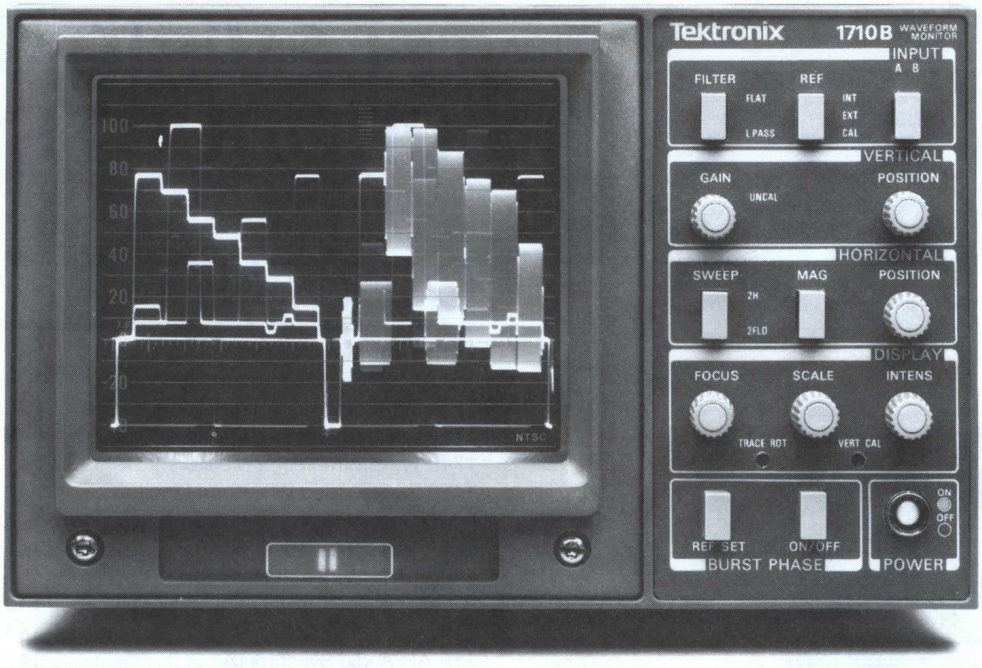
*Newly enhanced, the 1450-1 SYSTEM M DEMODULATOR now has BTSC Multichannel sound capabilities.*

# TELEVISION PRODUCTS

## CONTENTS


**1710B** Waveform/Vector Monitors ..... 138
**TSG-170A** NTSC Television Generator ..... 139
**TSG-300** Component Television Generator . 139
**1750** Waveform/Vector Monitors ..... 140
**1740** Waveform/Vector Monitors ..... 141
**1480** Series Video Waveform Monitors ..... 142
**R520** Series Vectorscopes ..... 142
**528A** Video Waveform Monitor ..... 143
**1420** Series Video Monitoring Vectorscopes ..... 143
**110S** ..... 144
**118-AS** Audio Synchronizer ..... 144
**1410/11R/12R** Series Test Signal Generators ..... 145
**1910** NTSC Digital Generator/Insertor ..... 145
**1450-1/-2/-3** Series Television Demodulator 146
**1980** Automatic Video Measurement Set ..... 147
**1434** Video Noise Generator ..... 148
**1470/1474** NTSC Generators ..... 148
**R148/R148-M** PAL Test Signal Generator ... 148
**1440** Automatic Video Corrector .... **1430** ....148
**650HR** Series Color Picture Monitors ..... 149

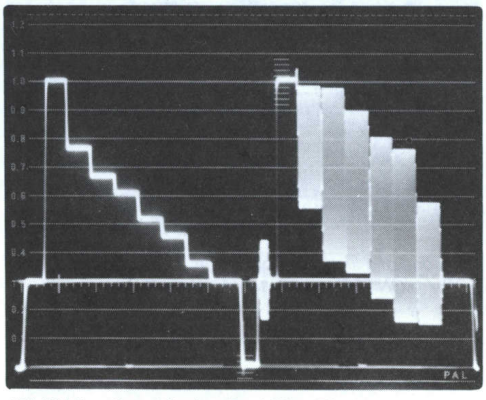
*With one-of-a-kind capability, the 1710B Series WAVEFORM MONITOR is easy to use and afford.*




*1710B Waveform Monitor—Dual Filter Display*

## 1710B Series Waveform Monitors

- Cost Effective
- Easy Operation
- Burst Phase Indicator
- Dual Filter Display
- Half Rack Width
- Bright CRT Display
- Internal Graticule
- Light Weight
- Low Power Consumption
- Dc Operation
- Available in NTSC and PAL Standards




*1711B Waveform Monitor Dual Filter Display*

The 1710B Series waveform monitors provide all of the commonly used display modes. In addition, the 1710B Series adds relative burst phase indication and dual filter display. All of this in a cost effective package for the user who wants high quality at a low price. These new monitors are mechanically compatible and retrofit into an existing system that uses half rack width, 5¼ inch waveform monitors.

Because of its extreme light weight, low power consumption, and dc operation (field installable kit) the 1710B Series is ideal for field production, mobile operations, and any other application where space, power consumption and/or portability are prime considerations.

### Easy Operation

Designed for easy operation of this powerful tool, the controls are identified with clear nomenclature and positioned in a logical order.

### Burst Phase Indication

The relative burst phase between inputs are displayed on the LED bar graph. The center green LEDs indicate the two signals are phase matched. The yellow ones warn the phase is slipping out of an acceptable range. Finally, the red LEDs flag an unacceptable amount of phasing error. This feature allows one instrument to do the complete job of timing and phasing in a basic television system.

### Dual Filter Display

The dual filter display allows the user to view both the complete video signal and the luminance information at the same time using just one instrument. This eliminates the need for switching back and forth betweeen filters and makes the instrument easier to operate. Ideal for camera setup.

### Bright CRT Display

The bright CRT display permits use of the 1710B Series in high ambient light conditions. Brightness remains high in the magnified sweep modes enhancing the 1710B's use in system timing applications. The internal graticule is parallax-free to reduce errors and improve its monitoring and measuring capabilities.

### NTSC and PAL Standards

The 1710B Series waveform monitors are available in both NTSC and PAL versions.

| | |
|---|---|
| 1710B | NTSC |
| 1711B | PAL |

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.2 |
| Height | 214 | 8.4 |
| Depth | 429 | 16.9 |
| **Weight ≈** | **kg** | **lb** |
| Net | 3.6 | 8.0 |

## ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate optional accessories to configure for rack, bench or portable use.

**1710B** Waveform Monitor (NTSC System Applications) **$1,890**

**1711B** Waveform Monitor (PAL System Applications) **$1,890**

### OPTIONAL ACCESSORIES

**Cabinet** — Plain. Order 1700F00 **$60**

**Cabinet** — Portable. Order 1700F02 **$85**

**Cabinet** — MPS Case. Order 1700F03 **$120**

**Side-By-Side Rack Mount** — For mounting two half-racks (1750, 528A, etc). In a standard 19 inch rack. Order 1700F05 **$180**

**Blank Panel Adaptor** — For the side-by-side rack mount. Order 016-0116-00 **$60**

**Snap-On Front Cover** — High impact plastic. Order 200-1566-00 **$18**

**Flip Stand Feet** — For modular carrying case, stands extend normal feet for tilted viewing (two required). Order 348-0618-01 **$7.25**

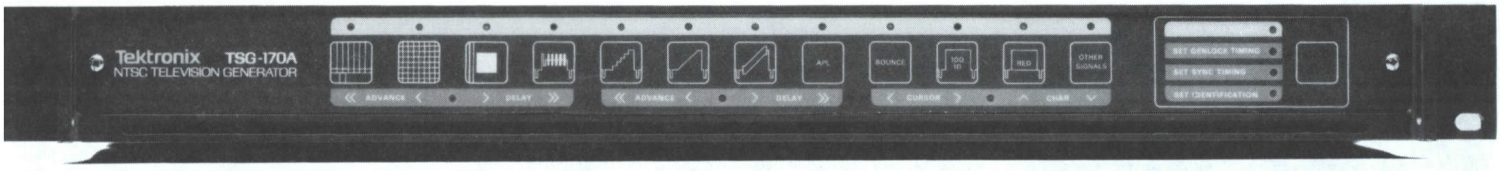
**Viewing Hood** — For high ambient light environments. Order 016-0475-00 **$10**

**Dc Operation Kit** — 12 VDC. Order 1700 F10 **$200**

**Camera** — C-5C Option 02 (Regular). **$465**
C-7 Option 03 (Automatic). **$565**

**Battery Pack** — Requires 1700F03 case and 1700F10 DC operations kit. Order BP1 **$550**

**For complete Television product information, check box on the business return card in this catalog.**




*TSG-170A NTSC Television Generator*

## *NEW* TSG-170A

### NTSC Television Generator

**Simple, Effective Test Signal Complement**

**RS-170A Sync Pulse Generator with Digital Genlock**

**Separate Timing Controls for Sync and Test Signals**

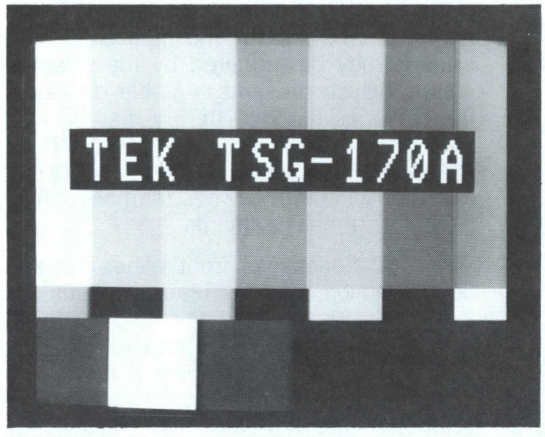
**Separate SMPTE Bars Output with Programmable ID (Option 01)**

**Audio Tone Output (Option 01)**

The Tektronix TSG-170A NTSC Television Generator offers you the test signals you need plus the advantages of master and genlock sync capability. It provides true 10-bit digital signal accuracy with a full complement of test signals and a stable RS-170A sync generator.

The rugged, compact TSG-170A is designed to support both operational and maintenance requirements. The TSG-170A Option 01 provides even more versatility by adding a separate SMPTE bar generator, programmable identification, and audio tone output.

- SMPTE Bars
- Convergence
- Pulse & Bar with Window
- Multiburst
- 5-Step Luminance Staircase
- Luminance Ramp
- Modulated Ramp
- Selectable 10% or 90% APL
- Bounce
- 10 and 100 IRE Flat Fields
- Red Field
- Multibars
- NTC7 Composite
- System Test Matrix
- Monitor Setup Matrix
- 5 MHz Line Sweep
- Multipulse
- DAC Calibration Signals

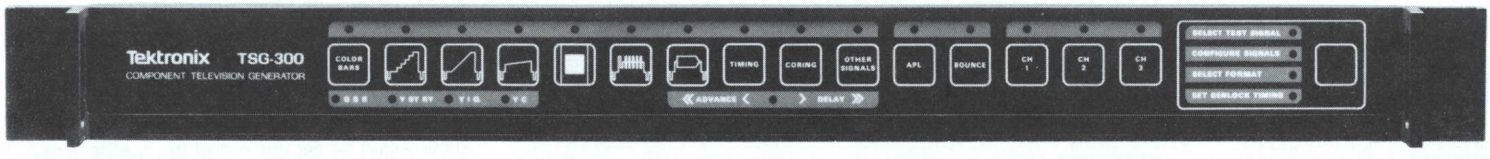



*SMPTE Bars with Character ID (Option 01)*

### ORDERING INFORMATION

**TSG-170A** NTSC Television Generator **$4,800**

**Option 01** — Adds a separate SMPTE Bars output with 12 Character ID and Audio Tone Output. **+$1,000**




*TSG-300 Component Television Generator*

## *NEW* TSG-300

### Component Television Generator

**Multiple Formats Including RGB, SMPTE Parallel, Betacam®, M**

**No Need for Test Signal Transcoding**

**Test Signal Complement Tailored to Component Systems**

**10-Bit, 13.5 MHz Digital Signal Generation**

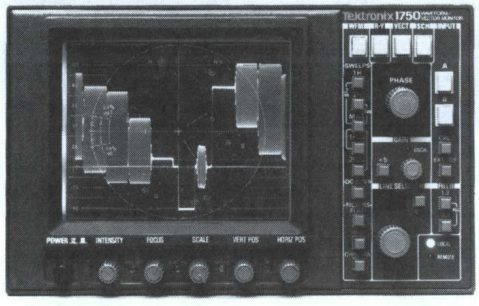
**Compatible with 525/60 and 625/50 Systems**

The versatile TSG-300 Component Television Generator provides direct digital test signal generation in a wide range of commonly used formats, without need for format transcoders. This flexibility, combined with simple operation and Tektronix signal quality, makes the TSG-300 the ideal choice for applications ranging from research and development to routine maintenance of new component-based ENG equipment. The TSG-300 test signal complement includes color bars, linearity, pulse and bar, and multiburst, as well as new component test signals.

### ORDERING INFORMATION

**TSG-300** Component Television Generator **$8,550**

**For complete Television product information, check box on the business return card in this catalog.**



*1750 Waveform/Vector Monitor—Dual Filter/Simultaneous Display*

## 1750 Series Waveform/Vector Monitors

**Two Instruments in One**

**SCH Phase and Color Framing**

**R-Y (V-Axis) Mode**

**RGB/YRGB Mode**

**Remote Control Capability**

The Tektronix 1750 Series offers comprehensive monitoring and measurement of television signals, including SCH phase and color framing, in one compact unit. While similar in appearance to the 1740 instruments, the 1750 has enhanced performance in each of its operating modes.

The unique SCH phase display presents horizontal sync timing relative to reference subcarrier (burst) for verification of signal format and color framing. This mode enables easy analysis and monitoring of these important characteristics of the television signal; a task which previously required complex techniques, highly skilled operators and/or additional instrumentation. The 1750's SCH phase and color frame displays are derived from the standard composite signals. No extra pulses or added signal details are required.

The 1750's SCH capability makes it particularly valuable in production and editing environments where maintenance of SCH phase and color frame are critical considerations. Applications include VTR bridges, camera control units, switcher consoles, master control, mobile and field production units, and in maintenance operations supporting any of these areas.

The 1750's half-rack package allows easy installation in environments where space and power requirements are important considerations. The 1750 is mechanically compatible with 528A, 1710B, 1420, and 1740 Series Tektronix instruments.

### Waveform Mode

The waveform mode vertical response is controlled by selectable flat, chroma, and luminance (IRE) filters. A backporch slow clamp is controllable from the front panel. An internal jumper reprograms the clamp timing for sync tip operation.

The 1750 has pushbutton selection of H, 2H, V, and 2 V horizontal sweeps. A magnifier provides calibrated sweep speeds of 1 μs/div and 0.2 μs/div at the line display rates, and about 20X magnification of the vertical rate display. The faster sweep speeds are useful for determination of horizontal blanking, pulse widths, risetimes, and other timing details of the signal, while the magnified vertical sweep allows viewing of the vertical blanking interval.

The internal calibrator signal in the 1750 is useful for verification of both video amplitude and sweep timing calibration. Crystal control of the calibrator waveform provides an accurate 1 V p-p squarewave and 10 μs timing interval.

The sweeps may be locked to the selected signal (A or B input), or to a separate external reference input. The horizontal rate sweeps may be triggered by the selected source (which presents a stable display in the presence of sync jitter) or may be AFC controlled (which displays sync jitter for analysis). Use of the AFC sweep control can also reposition the H sweep for more convenient timing measurements.

The 1750 Series has front panel line and field selection, an LED readout of the selected line number, and a video output with a strobe pulse on the displayed line. The 1750 (NTSC) will display line 8 thru 23 of either monochrome field (color fields 1,3 or fields 2,4). The 1751 (PAL) will display lines 6 thru 21 or 319 thru 334. The line selection range may be extended to any line of the frame by the use of rear panel remote control input in conjunction with the front panel controls.

The line selection function is operational in waveform, R-Y, and vector modes. These features provide convenient in-service monitoring or measurement of field blanking interval test or data signals.

### R-Y (V-Axis) Mode

In this mode the display is similar to a waveform display with the demodulated chrominance signal on the vertical axis and the selected sweep on the horizontal axis. Any demodulation axis may be set with the phase control; properly setting the display of burst in the vector mode will ensure R-Y axis decoding when the R-Y mode is selected.

There are differential phase markings on the graticule for use in this mode. Resolution of differential phase error is about twice that of vector measurement techniques, and the displayed errors may be correlated with time and luminance amplitude by using modulated staircase or modulated ramp test signals.

### SCH Phase Mode

This display is a combination of the burst vectors of the vector display and a bright dot on the outer degree circle of the vector graticule. The position of this "sync dot" around the circle represents the timing (phase) of the horizontal sync edges relative to the reference subcarrier. An individual signal may be analyzed for proper format (for proper SCH phase) without any additional reference.

Since it is possible for two signals to be properly formatted but not properly timed to each other (i.e., a color framing error exists), the 1750 has provision for using an external reference input for its subcarrier phase reference. When the external reference mode is used, the display shows the burst phase and sync timing of the selected signal relative to the burst of the reference signal, simultaneously indicating the SCH phase of the selected input signal and its color frame relative to the external reference signal.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 216 | 8.5 |
| Height | 133 | 5.3 |
| Depth | 460 | 18.2 |
| **Weight** | **kg** | **lb** |
| Net | 8.0 | 18.0 |

## ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate optional accessories to configure for rack, bench or portable use.

**1750** Waveform/Vector Monitor (NTSC Applications) **$5,900**

**1751** Waveform/Vector Monitor (PAL Applications) **$5,900**

### OPTIONAL ACCESSORIES

**Cabinet** — Plain. Order 1700F00 **$60**

**Cabinet** — Portable. Order 1700F02 **$85**

**Cabinet** — MPS Case. Order 1700F03 **$120**

**Side-By-Side Rack Mount** — For mounting two half-racks (1750, 528A, etc.) in a standard 19 inch rack. Order 1700F05 **$180**

**Blank Panel** — For one half of the side-by-side rack mount. Order 016-0116-00 **$60**

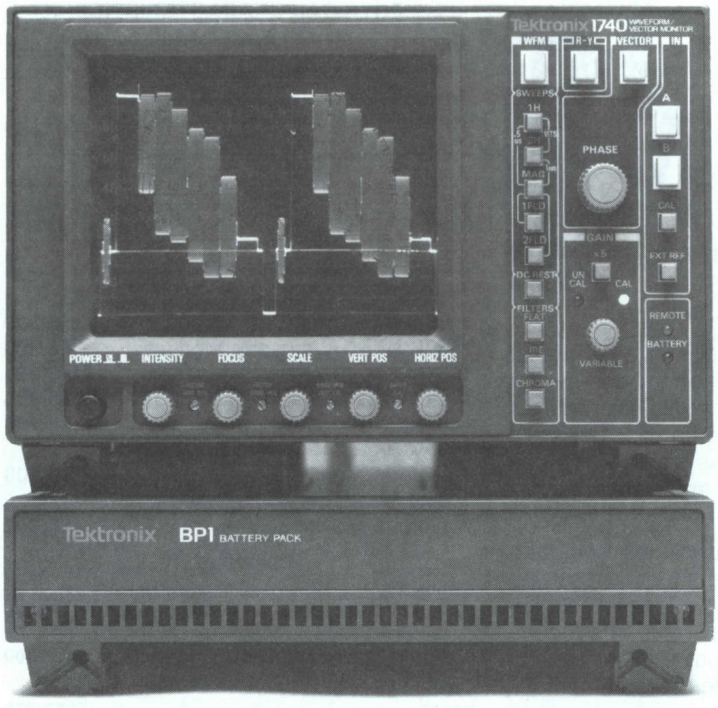
**Snap-On Front Cover** — High impact plastic. Order 200-1566-00 **$18**

**Flip Stand Feet** — For modular carrying case, stands extend normal feet for tilted viewing (two required). Order 348-0618-01 **$7.25**

**Viewing Hood** — For high ambient light environments. Order 016-0475-00 **$10**

**Camera** — Use C-30 Option 01 with adaptor 016-0269-03, or C-5C Option 02 or 04, or standard C-4. (See camera section of this catalog.)

**For complete Television product information, check box on the business return card in this catalog.**




*1740 Waveform/Vector Monitors with optional carrying case and battery pack.*

## 1740 Series Waveform/Vector Monitors

- Two Instruments in One
- Optional Dc Power Capability
- Bright CRT Display
- R-Y (V-Axis) Mode
- VITS Monitoring
- RGB/YRGB Display Capability
- Remote Control Capability
- Available in NTSC, PAL, and PAL-M

Similar to the 528A and 1420 Series products, the 1740 Series provides all the basic waveform monitoring and vectorscope functions, but in a single, compact package. In addition, the 1740 Series adds dc power operation (optionally), single line vertical interval display which is internally preset, an R-Y/sweep mode for differential phase measurements, and remote control of waveform/vector mode and most of the front panel sweep and vertical amplifier response functions.

The 1740's half rack width package allows easy installation where space and power requirements are important considerations. The 1740 is mechanically compatible with the 528A, 1710B, 1420 and 1750 Series instruments.

Typical applications include video signal monitoring in VTR bridges, camera control units, production switcher consoles, and in mobile vans and field productions.

### Optional Dc Power Capability

Two instrument options provide a dc Input for powering the monitor from a 12 volt dc power source. Option 07 provides the dc capability. Option 11 provides the dc capability and includes a portable case and the BP1 Battery Pack as the power source. The BP1 quickly and securely mounts to the bottom of the portable case. Total package weight of the instrument with the BP1 mounted is approximately 13.6 kg (30 lb).

A 1740 Series instrument will operate from a BP1 for at least two hours before recharging is required. Spare BP1 Battery Packs are available as optional accessories.

### Bright CRT Display

The bright CRT display permits use of the 1740 Series in high ambient light conditions, such as those encountered in field production applications. Brightness remains high in the 1 $\mu$s and 0.5 $\mu$s magnified sweep speeds, thus enhancing the 1740's use in system phasing applications. The internal waveform graticule and the external vector graticule are independently illuminated. A parallax free composite internal graticule, including both the waveform and vector features, is available (Option 06).

### R-Y (V-Axis) Mode

The demodulated chrominance may be displayed with a horizontal sweep using the R-Y mode for NTSC signals or the V-axis mode for PAL or PAL-M signals. When the burst is phased properly in the vector mode, the R-Y mode displays the chrominance demodulated on the R-Y axis (V-axis in PAL systems). There are differential phase markings on the right side of the vector graticule that are calibrated for use in this mode. Different sweep speeds may be used to examine differential phase as a function of time.

### VITS Monitoring

VITS (Vertical Interval Test Signals) or ITS (Insertion Test Signals) can be monitored in all modes. Each instrument model is internally set for a particular line. The 1740 is set to display line 19, usually occupied by the VIRS. The 1741 is set to line 17/330, and the 1742 to line 17/280. The 1740 may be reset for any line from 6 through 36, the 1741 from line 3/316 through 33/346, and the 1742 from line 3/266 through 33/296.

### RGB/YRGB Display

Facilities for a parade display of camera RGB signals are included in all 1740 Series instruments. The monitor's REMOTE connector accepts the required enable and three-step staircase signals from the camera. An internal jumper change permits display of a YRGB parade signal.

### Remote Control Capability

Remote control of input channel selection, mode, sweep speeds, and vertical amplifier filters is available through a rear panel connector. The remote function is useful for VTR applications.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 216 | 8.5 |
| Height | 133 | 5.3 |
| Depth | 460 | 18.1 |
| **Weights** | **kg** | **lb** |
| Net | 8.2 | 18.8 |
| Battery Pack | 13.6 | 30.0 |

## ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate options or optional accessories to configure for bench or portable use. **Option 06 is recommended.**

**1740 Option 01** Waveform/Vector Monitor (NTSC Applications) **$4,000**

**1741 Option 01** Waveform/Vector Monitor (PAL Applications) **$4,000**

**1742 Option 01** Waveform/Vector Monitor (PAL-M Applications) **$4,400**

**OPTIONS**

**Option 06** — (Composite internal graticule, waveform and vector.) **+$30**

**Option 07** — (Adds dc power operation capability, must be installed during manufacture.) **+$60**

**Option 11** — (Portable carrying case, dc power operation, and a BP1 Battery Pack.) **+$650**

**OPTIONAL ACCESSORIES**

**Cabinet** — Plain. Order 1700F00 **$60**

**Cabinet** — Portable. Order 1700F02 **$85**

**Cabinet** — MPS Case. Order 1700F03 **$120**

**Side-by-Side Rack Mount** — For mounting two half-racks (1740, 528A, etc) in a standard 19 inch rack. Order 1700F05 **$180**

**Blank Panel** — For one half of the side-by-side rack mount. Order 016-0116-00 **$60**

**Snap-On Front Cover** — High impact plastic. Order 200-1566-00 **$18**

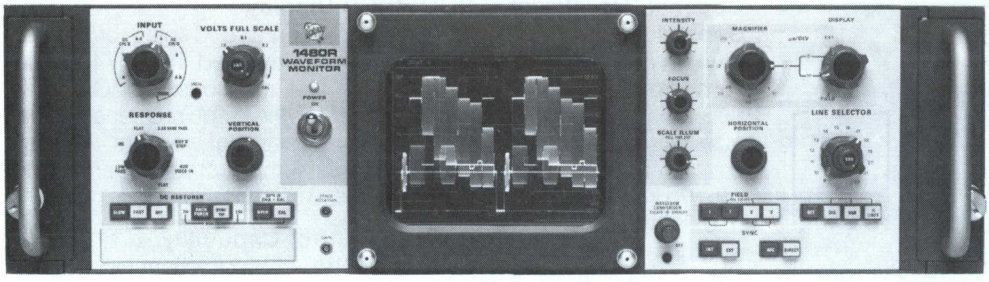
**Flip Stand Feet** — For modular carrying case, stands extend normal feet for tilted viewing (two required). Order 348-0618-01 **$7.25**

**Viewing Hood** — For high ambient light environments. Order 016-0475-00 **$10**

**Camera** — Use C-30 Option 01 with adaptor 016-0269-03, C-5C Option 02 or 04, or standard C-4, (See camera section of this catalog).

**Battery Pack** — Order BP1. **$550**

**For complete Television product information, check box on the business return card in this catalog.**




*1485R Option 01 PAL/NTSC Dual Standard Waveform Monitor (Rackmount)*

## 1480 Series Waveform Monitors

**Bright CRT Especially Suitable for Vertical Interval Testing**

**Advanced Measurement Modes**

**Amplitude Measurement Accuracy Approaching 0.2%**

**Digital Selection of Line and Field**

**Probe Input Option**

**15-Line Display for VTR Applications**

**Full feature capability for demanding video measurements in a range of applications.** The 1480 Series was designed to meet the monitoring needs of CCU, VTR, control room, transmission facilities, transmitter and special systems with optimum accuracy, precision and performance. It features a variety of advanced measurement modes, amplitude measurement accuracy approaching 0.2%, plus an exceptionally bright CRT that's especially suitable for vertical interval testing . . . bright enough for one vertical interval test signal selected out of four fields to be seen with ease even in a well lighted area. Digital selection of line and field assures positive identification of displayed information.

In addition to a 0.2% amplitude standard, the 1480 Series provides superior resolving power through calibrated five-times expansion of the vertical display, plus offset comparison and fine CRT spot size for making highly accurate amplitude measurements.

A unique overlay mode makes it possible to superimpose portions of waveform displays for exact, side-by-side comparison of levels.

Among many additional features are a probe input option, AFC sweep synchronization, selectable filters and 15-line display for VTR applications.

The 1480 Series is available in NTSC, PAL, PAL-M and NTSC/PAL Dual Standard versions.

### PHYSICAL CHARACTERISTICS

| | 1480C | | 1480R | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 216 | 8.5 | 482 | 19.0 |
| Height | 210 | 8.3 | 133 | 5.3 |
| Depth | 430 | 16.9 | 457 | 18.0 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 9.8 | 21.5 | 11.2 | 24.6 |
| Shipping | 24.1 | 53.1 | 24.1 | 53.1 |

### ORDERING INFORMATION

| | |
|---|---|
| **1480C NTSC** Waveform Monitor | **$6,300** |
| **1480R NTSC** Waveform Monitor | **$6,300** |
| **1481C PAL** Waveform Monitor*1 | **$5,865** |
| **1481R PAL** Waveform Monitor*1 | **$5,865** |
| **1482R PAL-M** Waveform Monitor | **$6,790** |
| **1485C PAL/NTSC** Dual Standard Waveform Monitor*1 | **$6,300** |
| **1485R PAL/NTSC** Dual Standard Waveform Monitor*1 | **$6,300** |

**OPTIONS**

**Option 01** — 1 MΩ, 20 pF Probe Input (not available with Option 06, probe not included). **+$300**
Suggested Probe: P6108A 10X Probe 2 m (010-6108-13); or 3 m (010-6108-15). **$100**

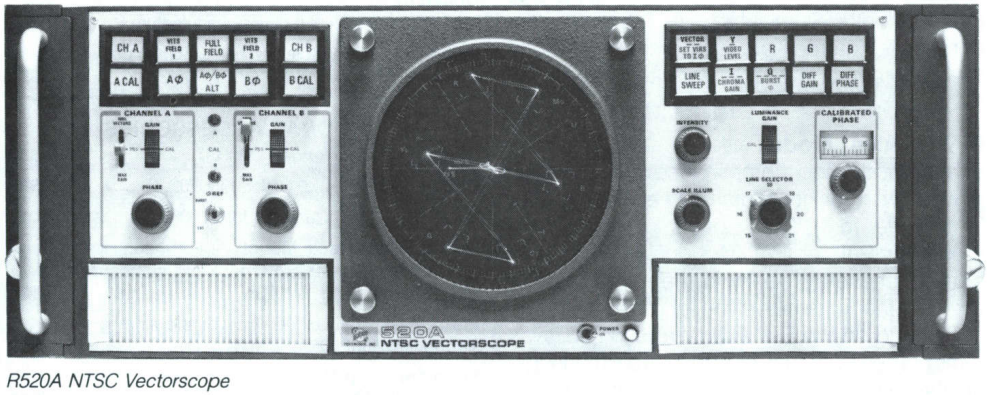
**Option 06** — (1480R only) 124 Ω WECO Style Inputs. **+$2,075**

**Option 07** — Slow Sweep*2 (Option 07 performance included with Option 06. Do not order with Option 06). **+$510**

**Option 08** — (1481C, 1481R, 1485C and 1485R only) SECAM Field Identification. **+$315**

**1 1481C/R, 1485C/R meets European Broadcast Union Tech. 3221-E, Guiding Principles for design of Television Waveform Monitors.*

**2 Option 07 satisfies EBA Tech 3321-E § 3.2.2.*




*R520A NTSC Vectorscope*

## R520A Series Vectorscopes

**Luminance Amplitude**

**Chrominance Amplitude and Phase**

**Precision Differential Gain and Phase**

**Outstanding accuracy and versatility in a video measurement vectorscope.** The 520A Series offers advanced capability that enables measurements of the chrominance signal and distortions thereof to be made with a high degree of precision. It effectively complements the 1480 Series in applications requiring highly accurate measurements of luminance amplitude, chrominance amplitude and phase, differential gain, differential phase and other distortions.

The 520A Series provides polar coordinate displays with which to easily detect errors in color encoding, videotape recording and playback, or transmission processes that interfere with phase and/or amplitude relationships and lead to color errors in a television picture. Large phase shifts can be read from the parallax-free vector graticule, and a precision calibrated phase shifter is provided for measuring small phase shifts.

Differential gain and differential phase measurements can be made with accuracy to better than 1% or 1°. Using a trace overlay provides excellent resolution for measuring very small phase errors.

Other features include a voltage step-up termination option, VITS observation from front panel selected lines and dual vector display.

The 520A Series is available in NTSC, PAL and PAL-M versions.

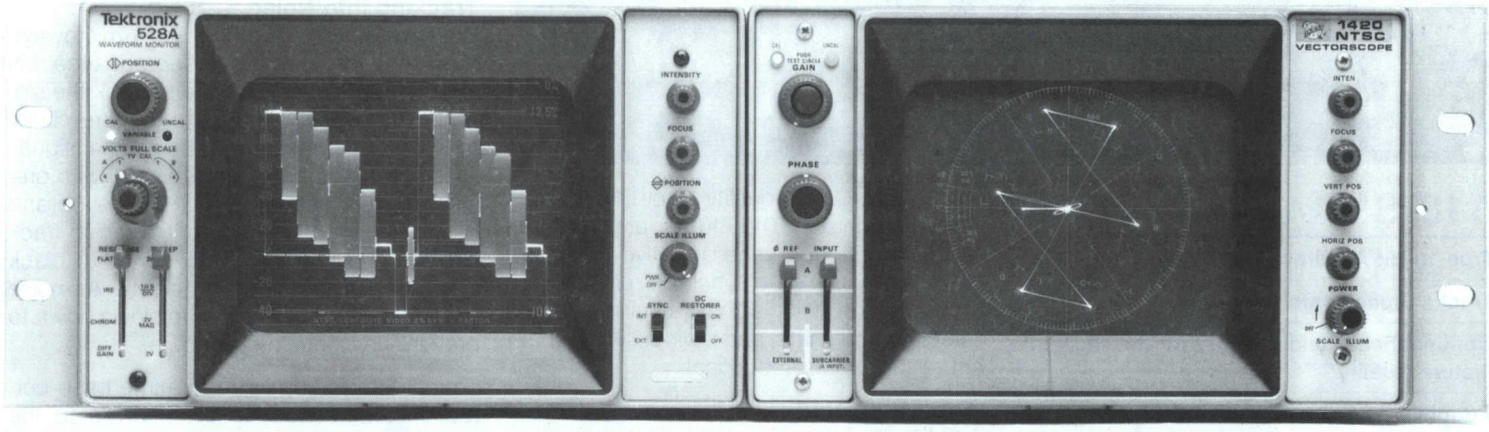
### PHYSICAL CHARACTERISTICS

| **Dimensions** | **mm** | **in** |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 178 | 7.0 |
| Depth | 483 | 19.8 |
| **Weights** | **kg** | **lb** |
| Net | 15.0 | 33.0 |
| Shipping ≈ | 27.7 | 61.0 |

### ORDERING INFORMATION

| | |
|---|---|
| **R520A** NTSC Vectorscope | **$8,525** |
| **R521A** PAL Vectorscope | **$8,050** |
| **R522A** PAL-M Vectorscope | **$9,540** |

**For complete Television product information, check box on the business return card in this catalog.**




*528A Waveform Monitor mounted side-by-side with a 1420 Vectorscope.*

## 528A/1420 Series

**Parallax-Free Internal Graticule**

**Half Rack Width**

**Proven Performance**

**Available in NTSC, PAL, PAL-M Models**

### 528A Waveform Monitor

**The best of the basics in a waveform monitor that's easy to use. . .and has plenty of uses!** The popular, highly-capable 528A provides proven performance in all television applications that require consistent quality, video waveform monitoring. Its half-rack width makes it possible to mount the 528A next to another monitor, the most common choice being a Tek 1420 Series vectorscope. A carrying case is also available for the 528A for field or bench applications.

An illuminated, internal graticule CRT ensures parallax-free viewing of bright, easy-to-read displays. With its simple front panel controls, the 528A enables you to monitor sync and video levels, display RGB or YRGB format, check and adjust system timing and perform many camera adjustment procedures with accuracy and ease. It also meets requirements of videotape recorder monitoring bridges for monitoring and set-up, limited differential gain measurements, line time tilt measurements, pulse response (K factor) measurements and more.

Features include two video inputs, variable sensitivity control, video output of displayed signal, four frequency response and four sweep selection positions.

### 1420 Series Vectorscopes

**Chrominance signal monitoring in a compact, compatible package.** The 1420 Series is an effective answer to vector monitoring requirements in the same applications which are well served by the 528A, including VTRs, camera control units, video production and postproduction monitoring. Its half-rack width makes a 1420 Vectorscope ideally suited for mounting side-by-side with a 528A. Together they provide continuous displays of the luminance, sync and chrominance characteristics of a video signal.

The parallax-free internal graticule is designed especially for vector displays of color bars and burst. A special graticule feature that enables differential gain or phase errors to be determined to within 5% and 2° offers sufficient accuracy for many applications. (Higher resolution differential gain and phase measurements should be made with a 520A Series vectorscope.)

Additional 1420 Series features include two signal inputs, an external subcarrier reference input and continuous 360° phase rotation of a displayed signal.

The 1420 Series is available in NTSC, PAL and PAL-M versions.

**PHYSICAL CHARACTERISTICS**

| Dimensions | mm | in |
|---|---|---|
| Width | 216 | 8.5 |
| Height | 133 | 5.3 |
| Depth | 470 | 18.5 |
| **Weights (528A)** | **kg** | **lb** |
| Net (with accessories) | 6.8 | 15.0 |
| Shipping | 10.4 | 23.0 |
| **Weights (1420 Series)** | **kg** | **lb** |
| Net (with cabinet) | 7.0 | 15.5 |
| Net (without cabinet) | 5.9 | 13.0 |
| Shipping | 9.1 | 20.0 |

## ORDERING INFORMATION

These instruments are configured for rackmounting and are shipped without cases or covers. Order appropriate options and optional accessories to configure for bench or portable use.

**528A Option 01** Waveform Monitor (for use with 525 line systems) **$2,300**

**Option 03** — (Modified for use with 625 line systems and for 230 V ac power, unless otherwise specified.) **NC**

**1420 Option 01** Vectorscope (NTSC, factory wired for 115 V ac power) **$2,820**

**1421 Option 01** Vectorscope (PAL, factory wired for 230 V ac power) **$2,920**

**1422 Option 01** Vectorscope (PAL-M, factory wired for 115 V ac power) **$3,185**

### OPTIONAL ACCESSORIES

**Cabinet** — Plain. Order 1700F00 **$60**

**Cabinet** — Portable. Order 1700F02 **$85**

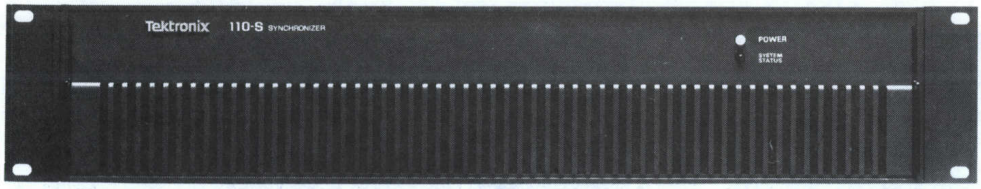
**Cabinet** — MPS Case. Order 1700F03 **$120**

**Side-by-Side Rack Adaptor** — For mounting two half-racks in a standard 19 inch rack. Order 1700F05 **$180**

**Blank Panel** —For one half of the side-by-side rack mount. Order 016-0116-00 **$60**

**Camera** — Use standard C-59AP, C-4 Option 02, or standard C-5C. (See camera section of this catalog).

**For complete Television product information, check box on the business return card in this catalog.**




## 110-S Video Synchronizer/TBC

**True 10-Bit Accuracy and Resolution**

**Tracks Signals into the Noise**

**Optional Four-Field Memory for the Highest Picture Quality**

**Adaptive Decoding—Minimizes Picture Shifts while Preserving Horizontal and Vertical Detail, Provides Exceptionally High Quality Picture Freeze**

**Adaptive Clamping—Minimizes Streaking on Noisy Signals**

**Digitally Precise RS-170A Sync and Burst Insertion**

**Passes the Vertical Interval**

**Processing Amplifier**

**Precalibrated Boards in Modular Design**

**Heterodyne Color Processing**

**Auto VTR Signal Recognition**

**Infinite Window Correction Range**

The 110-S is a high quality 10-bit, 4X fsc video synchronizer. The 10-bit architecture, adaptive decoding, and adaptive clamping combine to provide a synchronizer that performs well on noisy signals, minimizes horizontal picture shifts, and is virtually transparent to the processed signal.

### 10-Bit Precision

A Tektronix-designed 10-bit digitizer and a sampling rate of four times the subcarrier frequency result in negligible quantizing errors, low differential gain and phase, and a flat frequency response. Compared to 8-bit synchronizers, the 110-S has four times the accuracy and resolution. The resulting transparency to the video signal allows cascading of 110-S synchronizers in the signal path with minimum signal degradation.

### Tracking Into Noise

When noise from a fading ENG microwave feed or static interference degrades the S/N ratio, the 110-S will continue to track the signal. If the original sync and burst are clean, they may be passed with the original signal. Noisy sync and burst are replaced with precise, digitally-generated RS-170A sync and burst. The 110-S can be configured to track into the noise, freeze field, or go to black upon loss of the incoming signal. As noise increases, an adaptive clamp slows down to prevent horizontal streaking.

The 110-S TBC option adds time base correction for heterodyne color VTR's to the 110-S Synchronizer.

### ORDERING INFORMATION

**110-S** Video Synchronizer **$14,975**

**OPTIONS**

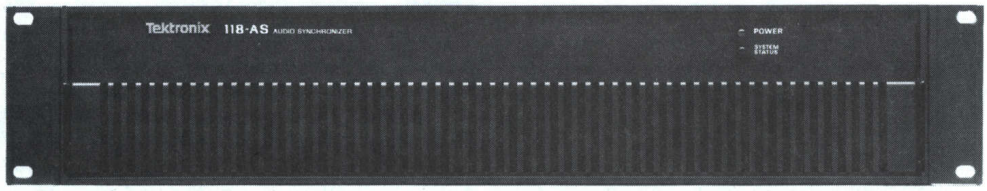
**Option 10** — Four-Field Memory Adaptive Decoder. **+$1,500**

**Option 20** — Adds time base correction for heterodyne color VTR's **+$2,000**

**110-RC** Remote Control Unit **$500**

**OPTIONAL ACCESSORY**

**Spare Parts Kit** — Order 020-0990-00 **$1,355**




## 118-AS Audio Synchronizer

**Automatic or Manual Control of Audio to Video Timing**

**Simple One-Wire Interface to 110-S Video Synchronizer**

**118-F02 Option Provides Interface to Other Video Synchronizers**

**Expandable to Three Channels for Stereo and Auxilliary Channel**

**Compensates for up to Ten Fields of Video Delay**

**93.75 kHz Sampling Provides Accurate Stereo Phasing and Flat Frequency Response**

**18-Bit Floating Point Code for Wide Dynamic Range**

**Built-In Diagnostics and Easy Module Access for Service**

The Tektronix 118-AS Audio Synchronizer provides automatic and/or manual control of audio delay to maintain proper audio to video timing. With 18-bit floating point code and 93.75 kHz sampling, the Tektronix 118-AS brings to audio synchronization the same high standards established for video synchronization by the Tektronix 110-S.

The 118-AS Audio Synchronizer automatically tracks the 110-S Video Synchronizer using a simple one-wire digital interface. The 118-F02 video interface board allows the 118-AS to automatically track the delay of other video equipment. Additional fixed audio delay may be added manually to compensate for audio to video timing errors present on an incoming signal.

The standard 118-AS is a single channel audio synchronizer, which may be expanded to two or three channels for stereo or second language applications.

### ORDERING INFORMATION

**118-AS** Single Channel Audio Synchronizer **$6,500**

**118-F01** Audio Channel Kit (adds one channel) **$2,700**

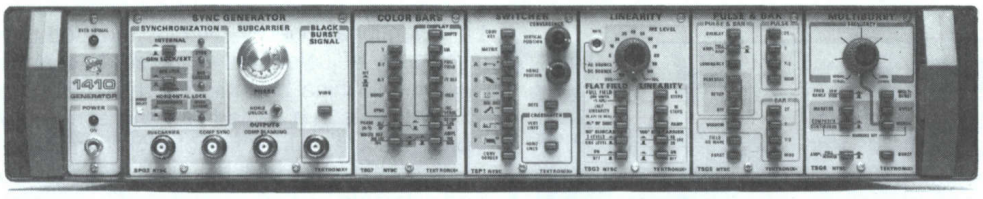
**118-F02** Video Interface Kit **$1,400**

**118-RC** Remote Control Unit **$1,400**

**OPTIONAL ACCESSORY**

Circuit Board Extender. Order 670-7754-00. (Same as 110-S Extender.) **$500**

**For complete Television product information, check box on the business return card in this catalog.**



*1410R Option 04 Test Signal Generator*

# 1410R/1411R/1412R

## NTSC, PAL, and PAL-M Generators

**Five Test Signal Generators and One Switcher**

**Conforms to EIA Standard RS-170A (1410R)**

**Sync to Subcarrier Phasing Maintained or Corrected**

**Color Frame Reference Output**

**Genlock to Composite Video**

**Lock to External References**

**Adjustable Blanking Widths**

**Adjustable Sync Delays (H and V)**

The 1410R Series sync and test signal generators are precision generators for use in studios, remote vans, maintenance facilities and anywhere high quality sync or test signals are required.

Three different models are available. The 1410R is for NTSC applications, the 1411R for PAL and the 1412R is for PAL-M applications.

### ORDERING INFORMATION

**1410R NTSC PACKAGES**
**STANDARD CONFIGURATIONS**

| | Option 03 | Option 04 |
|---|---|---|
| **TSG2** (Convergence) | x | |
| **TSG3** (Linearity) | x | x |
| **TSG5** (Pulse and Bar) | | x |
| **TSG6** (Multiburst) | | x |
| **TSG7** (Color Bars) | x | x |
| **TSP1** (Switcher) | | x |

**1410R** NTSC Mainframe and SPG2 Sync Generator **$4,200**

**OPTIONS**

**Option 03** — NTSC Package Installed and Tested Together. **+$3,460**

**Option 04** — NTSC Package Installed and Tested Together. **+$8,280**

**1411R PAL PACKAGES**
**STANDARD CONFIGURATIONS**

| | Option 03 | Option 04 |
|---|---|---|
| **TSG11** (Color Bars) | x | x |
| **TSG12** (Convergence) | x | |
| **TSG13** (Linearity) | x | x |
| **TSG15** (Pulse and Bars) | | x |
| **TSG16** (Multiburst) | | x |
| **TSP11** (Switcher) | | x |

**1411R** PAL Mainframe and SPG12 Sync Generator **$4,200**

**OPTIONS**

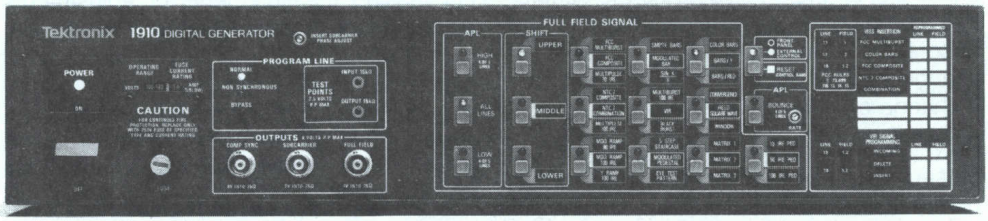
**Option 03** — PAL Package Installed and Tested Together. **+$3,000**

**Option 04** — PAL Package Installed and Tested Together. **+$7,500**

**PAL-M PACKAGES**

**1412R** PAL-M Mainframe and SPG22, TSG21 **$7,415**

**Option 05** — Adds TSG23/TSG25/TSG26/TSP21 Installed. **+$8,795**




# 1910 Digital Generator

**Four External VITS Inputs for Insertion of Teletext, Closed Captioning, Source ID, etc.**

**Nonvolatile Memory to Maintain Selected VITS and Full Field Signal Configuration after Power Interruption**

**Signal Stored in Replaceable PROMs so Your 1910 won't Become Obsolete**

**The Accuracy and Stability of an all-Digital 10-Bit Sync and Signal Generation (RS-170A)**

**User Friendly RS-232C Control Port for Added Versatility**

**New Signals (Eye Test Pattern, Special Multipulse, Color Multipulse), New Functions (VITS Sequence, Field Sequence and More)**

The 1910 Digital Generator is a state-of-the-art test signal generator designed for performance testing of NTSC video systems and equipment. The 1910 is especially suited where high accuracy and stability are required. It is also a VITS inserter (internal and external) with a full complement of signals that allow testing in studio, transmitter, production or research environments. Four external VITS inputs permit insertion of signals such as teletext, closed captioning, source ID, and other similar sources. These four inputs may be converted to four pulse outputs for use in a production environment.

External interfacing of the 1910 is controlled by an internal microprocessor and its nonvolatile memory. Test signals are stored as 10-bit digital words and converted to analog form by a 10-bit precision DAC (with deglitching to reduce differential gain and differential phase) to ensure signal accuracy as well as long term stability and repeatability.

Since all signals are stored in replaceable EPROMs, changing needs and industry standards will not cause obsolescence.

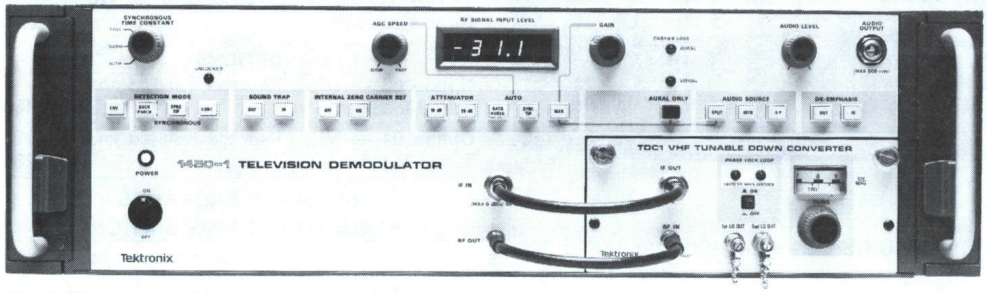
Control and versatility of the 1910 are greatly enhanced by the use of its RS-232 control port. Most functions of the 1910 can be controlled, reconfigured and saved. This includes VITS and full field signal selection, matrix signal creation, sequences and other features.

### ORDERING INFORMATION

**1910** Digital Generator **$9,990**

**Option 03** — CBC Test Signals. **NC**

**For complete Television product information, check box on the business return card in this catalog.**




*The 1450-1 is compatible with System M Television Transmission, the 1450-2 is compatible with System B/G, and the 1450-3 is compatible with System I.*

# 1450-1/1450-2/1450-3

**Measurement-Quality Performance for Negligible Distortion**

**Synchronous Detection Elminates Quadrature Distortion**

**Envelope Detection for Accurately Determined Differential Phase**

**Surface Acoustic Wave Filter Provides Precise Nyquist Slope; Excellent Long and Short-Term Stability**

**Digital Readout of Input Power Level for Easy, Accurate Field Strength Readings**

**Constant-Bandpass Characteristics Over Wide Dynamic Range**

**Any Single VHF or UHF Channel Operation**

**UHF and VHF Tunable Down Converters**

**Conforms to EIA Standard RS-462 (System M Only)**

The 1450-1 (System M), 1450-2 (System B/G) and 1450-3 (System I) demodulator mainframes are combined with a Tektronix Television Down Converter (TDC) to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible demodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.

High Performance Spectrum Analyzers for your RF measurements are described on pages 154-174.

### Tunable or Fixed-Channel Down Converters

For demodulating an RF signal at a TV channel frequency, the 1450 Series demodulator mainframes must be used with a Tektronix TDC. Three compatible TDCs are available for each system and provide a selection between tunable and fixed-channel performance. The TDC Fixed-Channel Down Converter supports your specified system channel number. Tunable Down Converters available for VHF and UHF channels are the TDC1 and TDC2 respectively.

Demodulation of the transmitter IF signal may be accomplished by using only the mainframe.

### Synchronous and Envelope Detection

The 1450 Series demodulators allow you to select either synchronous or envelope detection. Each method has advantages, yet both are required for full measurement capability. For instance, synchronous detection is necessary for measurements that can be seriously affected by quadrature distortion.

The 1450 Series demodulators have two synchronous video detectors operating in phase quadrature. One detects the in-phase signal; the other detects the quadrature component of the video signal. (The quadrature component is a measure of change in visual carrier phase resulting from a change of video level.)

However, if incidental phase modulation is present on the picture carrier, the amount of differential phase measured on a synchronously detected signal will be erroneous. Because of this, an envelope detector is necessary to determine the actual differential phase present. The envelope detector has linear transfer characteristics down to 3% carrier and so provides optimum modulation depth indication.

### Tektronix-Developed Surface Acoustic Wave Filter

The 1450 Series demodulators feature a SAW (surface acoustic wave) filter developed by Tektronix. It provides more precise Nyquist slope characteristics without group delay distortion, improves long-term and short-term stability, and lowers maintenance costs compared to conventional filter network circuitry.

In conventional demodulators, the more precisely the bandpass characteristics approach an ideal Nyquist curve, the more complex the filter network required. In the 1450 Series demodulator mainframes however, the bandpass characteristics are determined by just a single component, the SAW filter. Precision is the result.

Conventional tuned IF circuitry must be meticulously adjusted and is subject to change with mechanical and thermal shock. But the SAW filter is in a sealed unit and accurately provides the critical selectivity characteristics of the demodulator—and requires no adjustments.

### Constant-Bandpass Characteristics

The Tektronix 1450 Series demodulators offer constant-bandpass characteristics over the entire dynamic range of input signal level. Amplifiers in the mainframe operate at a constant gain, and pin-diode attenuators are used to adjust the overall gain of the demodulator. This more sophisticated approach to AGC (automatic gain control) is necessary to maintain constant-bandpass characteristics over the entire dynamic range of input power (−69 dBm to −3 dBm). Additional attenuation of 30 dB, available in 10 dB steps, can shift the range for higher input power levels. In addition to AGC, demodulator RF/IF gain control can be set for manual operation.

### Digital Reading of Input Power

With the accurate (to 0.1 dB) digital readout you get measurements of input power you can depend on at transmitter sites, remote sites, or, for calibrated field strength measurements.

### Split and Intercarrier Sound

For making measurements or adjustments on aural transmitters, the 1450 Series demodulators feature both split and intercarrier sound channels. The split carrier channel, which will operate without the presence of the visual carrier, may be used when making measurements on the aural transmitter only.

Four audio outputs give added measurement capability: a 600 Ω output, two low impedance outputs for driving a speaker or headphones, and a calibrated output for making deviation measurements with an ac voltmeter or an oscilloscope.

### Quadrature Distortion

Quadrature distortion occurs when a single sideband signal is demodulated with an envelope detector.

Quadrature distortion most severely affects the chrominance signal, causing a loss of brightness in highly saturated colors, especially those at high luminance levels. Narrow white picture elements against the dark backgrounds are reproduced at reduced brightness.

Synchronous detection of the television RF signal eliminates quadrature distortion, allowing the true performance of the transmitter to be determined.

## ORDERING INFORMATION

### SYSTEM M

**1450-1** Television Demodulator (Order one vision IF option) **$14,900**

**OPTIONS**

**Option 01** — 37 MHz Vision IF. **NC**

**Option 02** — 38.9 MHz Vision IF. **NC**

**Option 03** — 45.75 MHz Vision IF. **NC**

**For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-1 mainframe.**

Order one vision IF option and either Option 11 or 14.

**TDC Fixed Channel Down Converter** — (Stipulate channel number when ordering.) **$3,750**

**TDC-1** — Tunable Down Converter VHF Band. **$7,660**

**TDC-2** — Tunable Down Converter UHF Band. **$7,660**

**OPTIONS**

**Option 01** — 37 MHz Vision IF. **NC**

**Option 02** — 38.9 MHz Vision IF. **NC**

**Option 03** — 45.75 MHz Vision IF. **NC**

**Option 11** — System M Countries. **NC**

**Option 14** — System M Countries. **NC**

### SYSTEM B/G

**1450-2** Television Demodulator (Order both Option 02 and Option 09) **$11,900**

**OPTIONS**

**Option 02** — 38.9 MHz Vision IF. **NC**

**Option 09** — +90 ns/−170 ns Group Delay. **NC**

**For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-2 mainframe. Order both Option 02 and Option 12.**

**TDC Fixed Channel Down Converter** — (Stipulate channel number when ordering.) **$3,750**

**TDC-1** — Tunable Down Converter VHF Band. **$7,660**

**TDC-2** — Tunable Down Converter UHF Band. **$7,660**

**OPTIONS**

**Option 02** — 38.9 MHz Vision IF. **NC**

**Option 12** — System B/G/I Countries. **NC**

### SYSTEM I

**1450-3** Television Demodulator (Order Option 02) **$13,145**

**Option 02** — 38.9 MHz Vision IF. **NC**

**For demodulation of RF signals, one of the following three down converters must be plugged into the 1450-3 mainframe. Order both Option 02 and Option 12.**

**TDC Fixed Channel Down Converter** — (Stipulate channel number when ordering.) **$3,750**

**TDC-1** — Tunable Down Converter VHF Band. **$7,660**

**TDC-2** — Tunable Down Converter UHF Band. **$7,660**

**OPTIONS**

**Option 02** — 38.9 MHz Vision IF. **NC**

**Option 12** — System B/G/I Countries. **NC**

# 1980

## ANSWER with Measurement Software

**Unattended Monitoring of Video Signals from Studios, STLs, Earth Stations, and Transmitters**

**Full Spectrum of Timing, Frequency Response, Amplitude, Phase, and Noise Measurements**

**Waveform Plots for Analysis and Documentation**

**Remote Operation**

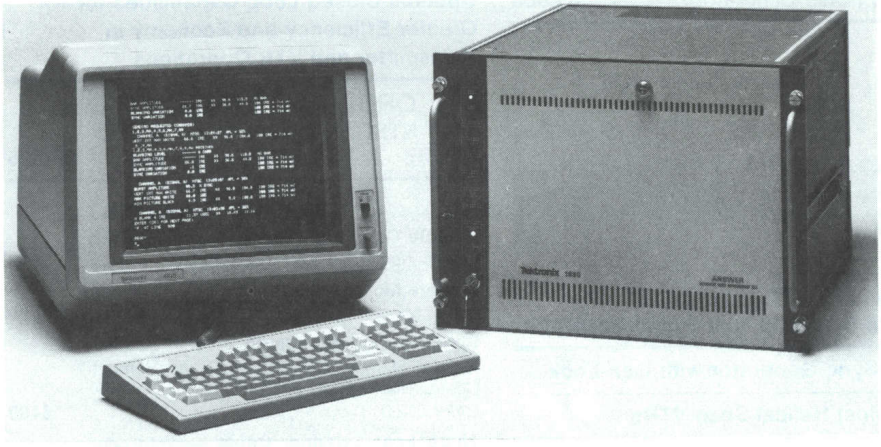
**Automatic Logging**

**User Definable Measurement Limits**

**Operator Initiated Individual Measurement**

**Vertical Interval Scan for Test Signal Locations**

**User-Defined Measurement Groups**



## ORDERING INFORMATION

For Base Unit Plus Software, Order:

**1980** ANSWER with Option 01, NTSC Applications Software **$28,150**

**1980** ANSWER with Option 04, NTSC Monitoring Software **$28,150**

**1980** ANSWER with Option 05, PAL Monitoring Software **$28,150**

**1980** ANSWER Monitoring with Option 06, PAL/NTSC Software **$30,990**

**Option 12** — Automatic Call Equipment Interface **+$600**

**For Software Only, Order:**

**1980 F04** **$6,300**

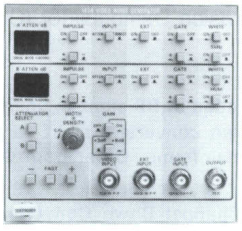
**1980 F05** **$6,300**

**1980 F06** **$9,145**

### OPTIONAL ACCESSORY

**Service Kit** — Order 067-1115-01 **$3,580**

**For complete Television product information, check box on the business return card in this catalog.**

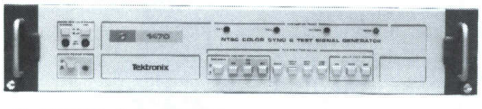


## *NEW* 1434 Video Noise Generator

- Calibrated Noise Levels
- White Noise
- Impulse Noise with Selectable Polarity, and Variable Width and Density
- Hum — 50 Hz or 60 Hz
- 5 kHz Sinewave
- Noise Gating
- Calibrated Video Attenuation
- Works with NTSC, PAL, PAL-M, and SECAM

### ORDERING INFORMATION

**1434** Video Noise Generator **$5,500**



## 1470/1474

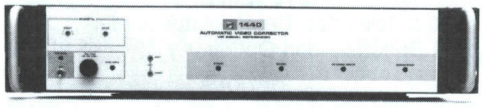
### NTSC Color Sync and Test Signal Generator

- Full Color Sync Generator with Gen-Lock
- Locks to Most Helical Scan VTRs
- Simple to Operate
- Compact and Economical
- Full Selection of Sync and Timing Signals
- Simplified Timing Via Multiple Subcarrier Phasing Controls

### ORDERING INFORMATION

**1470** Color Sync and Test Signal Generator (Rackmount) **$3,595**

**1474** Color Sync Generator (Rackmount) **$2,095**



## 1440 Automatic Video Corrector

- Reduces Operating Costs
- Extends Transmitter Tube Life and Reduces Maintenance Costs
- Maintains Consistent High Quality Color Pictures
- Automates Transmitter Modulation Level Control
- Maintains Correct Sync-To-Video Ratios During Line Voltage Fluctuations
- Automatic VIRS Referenced Correction of:
  - Overall Video Signal Amplitude
  - Chrominance to Luminance Gain Ratio
  - Black Level
  - Chrominance Phase
  - Burst Gain
  - Sync Gain
- Optional Closed Loop Capabilities for Greater Efficiency and Economy in Transmitter and VTR Operations

### ORDERING INFORMATION

**1440** NTSC Automatic Video Corrector **$6,325**

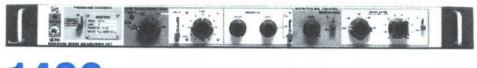
### OPTIONAL ACCESSORIES

**Remote Control Unit for 1440** — (Includes two connectors.) Order 015-0240-00 **$925**

**Remote Monitor Unit for 1440** — (Includes one connector.) Order 015-0239-00 **$1,080**

**Six Foot Extender Cable** — With connectors for use between the 1440 and Remote Control Unit or Remote Monitor Unit. Order 012-0131-00 **$400**

**Three Foot Extender Cable** — With connectors, for use between the 1440 chassis and the rear rackmounting section. Order 012-0637-00 **$390**



## 1430 Random Noise Measuring Set

- Conforms to CCIR Recommendation 568
- In-Service Testing
- Out-of-Service Testing
- Program Material Protected by Fail-Safe Provisions
- 525/60 or 625/50 Standards

### ORDERING INFORMATION

**1430** Random Noise Measuring Set (525/60) **$4,115**

**Option 01** — Random Noise Measuring Set (625/50). **+$85**

## R148/R148-M

### Test Signal Generators

- Insertion Test Signals (Per EBU, CCIR Recommendation 473-2, Annex 1)
- Full-Field Test Signals (Per CCIR Recommendation 567)
- Easily Reprogrammable
- Safe In-Service ITS Insertion (Per EBU Specifications)
- Noise Measurement
- APL Bounce Signal
- Source Identification Code
- Operates with Sound In Syncs
- Locks with Mixed Sync (Per EBU Homologation Specifications for ITS Generators) Subcarrier, PAL Pulse, Burst Flag, Comp Sync

### ORDERING INFORMATION

**R148 PAL** Test Signal Generator **$5,540**

**R148M PAL-M** Test Signal Generator **$8,700**

### OPTIONAL ACCESSORIES

**Noise Measurement Filters** — External filters are required with the 148 Generator when making noise measurements.

**Low Pass 6.0 MHz 625/50** — Order 015-0220-00 **$120**

**Noise Weighting 5.0 MHz 625/50** — Order 015-0215-00. **$95**

**Low Pass 4.2 MHz 525/60** — Order 015-0212-00 **$130**

**Noise Weighting 4.2 MHz 525/60** — Order 015-0214-00 **$95**

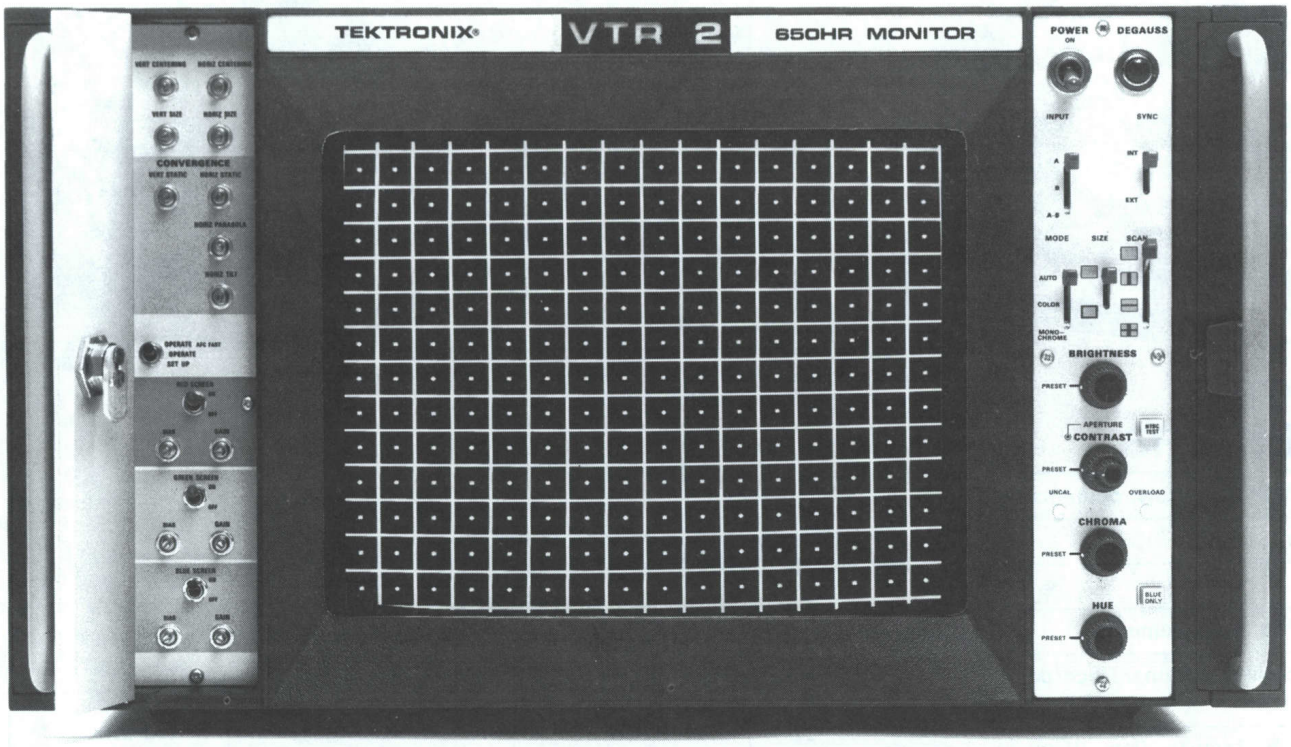
CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

**Low Pass 5.0 MHz** — Order 015-0213-00 **$130**

**Unified Noise Weighting Network** — Order 015-0283-00 **$75**

**Rackmount to Cabinet Conversion Kit** — Order 040-0768-00 **$55**

**For complete Television product information, check box on the business return card in this catalog.**




*650HR High Resolution Color Monitor*

## 650HR Series Color Picture Monitors

**High Resolution Display Plus Capability for Critical Signal Analysis**

**0.25 mm Triad Pitch High Resolution Trinitron CRT**

**Variable Aperture Correction**

**Precise Color Tracking Over Full Signal Range**

**Two Video Inputs with Differential (A-B) Capability**

**Video Inputs Isolated from Ground for Hum Rejection**

**Capability for Front Panel Switching of External Sync Inputs**

**NTSC, PAL, SECAM and Multistandard Versions Available**

**Precise Decoders with Outputs to Provide Vector Display on External X-Y Monitor**

**Unique Monochrome (White) Display of Decoded Blue Signal for Critical Analysis of Color Noise**

The Tektronix 650HR Series color picture monitors are designed for exacting applications where picture quality and signal quality analysis are particularly important. The 650HR uses a Trinitron CRT with resolution capabilities which exceed the performance of encoded television signals.

The decoders have sufficient chroma channel bandwidth to pass all of the information in standard signals.

The unique blue only mode feeds the decoded blue video signal to the red, green, and blue channels simultaneously. This produces a monochrome display with a high subjective sensitivity to chroma noise, allowing better analysis of video quality.

The chrominance channel may be manually switched to either the monochrome or color modes, or activated automatically by the presence of burst.

Circuits in the Tektronix 650HR Series are designed for color stability and consistency. Outputs are provided from the precision decoders and may be used to drive an X-Y monitor for a vector display. The regulated high voltage supply is not affected by extreme changes in APL even when calibrated brightness, at peak white, is set at 30 fL. Raster size is held within 1%, while excellent clamping maintains a stable black level with a 0% to 100% range of APL.

In 650HR Series color monitors, you can shift the picture either horizontally or vertically, or both (pulse cross). This lets you monitor sync, burst, blanking, vertical interval test, and reference signals. When the monitor is operating in any of these display modes, brightness is automatically advanced to permit observation of the sync pulses and burst. Expansion of the vertical scan is provided in the pulse cross and vertical delay modes, so you can view individual lines in the vertical blanking interval.

Versions of the 650HR are available for certain combinations of NTSC, PAL, SECAM and RGB. (See ordering information chart.)

The following special features are included in the SECAM version. Color sequencing from field identification signals or line burst. Reduced chrominance line crawl. Color sequence error indicater.

The 650HR Series monitors can be used in rack installations or separately in their own cabinets. (See separate TV Division catalog for detailed specifications.)

### PHYSICAL CHARACTERISTICS

| Dimensions | Cabinet | | Rackmount | |
|---|---|---|---|---|
| | mm | in | mm | in |
| Width | 426 | 16.8 | 483 | 19.0 |
| Height | 279 | 11.0 | 266 | 10.5 |
| Depth | 419 | 16.5 | 464*1 | 18.3*1 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 22.7 | 50.0 | 23.5 | 52.0 |
| Domestic Shipping | 28.5 | 65.0 | 30.4 | 67.0 |
| Export Shipping | 36.3 | 80.0 | 37.2 | 82.0 |

*1 *With handles*

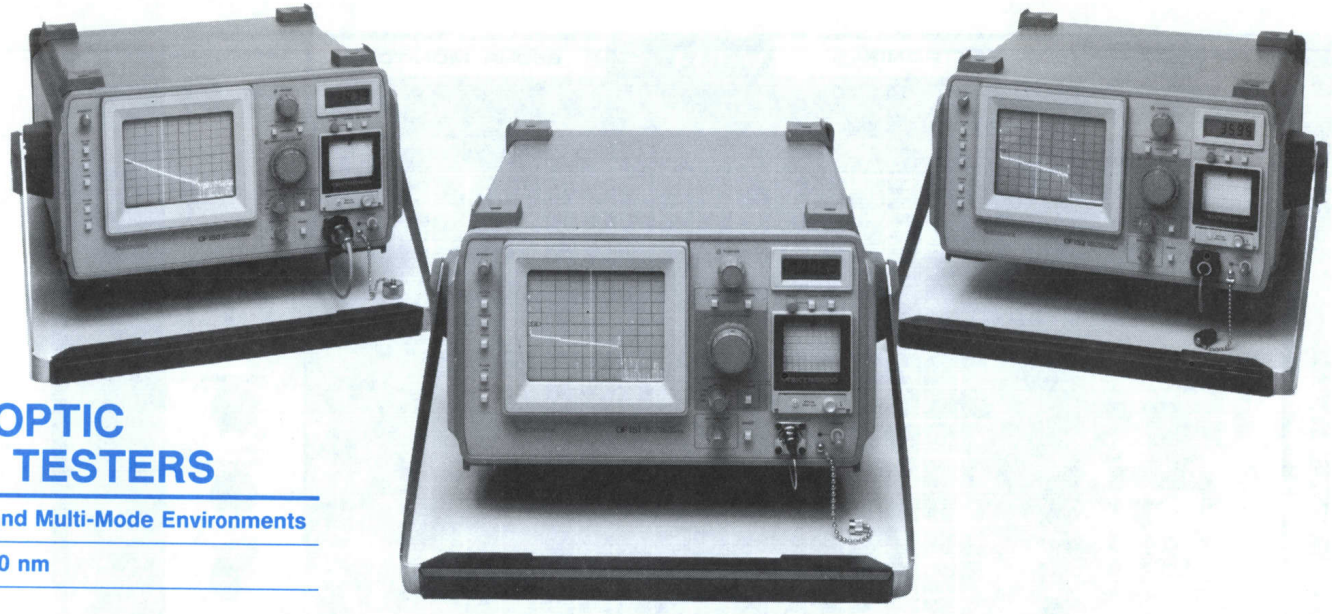
### ORDERING INFORMATION

All 650HR Monitors are shipped with rackmounting hardware. Cabinet version hardware is also included.

| MODEL NUMBER | NTSC | PAL | SECAM | RGB | PRICE |
|---|---|---|---|---|---|
| **650HR** | • | | | | $5,760 |
| **650HR-1** | • | | | • | $5,970 |
| **651HR** | | • | | | $6,010 |
| **651HR-1** | | • | | • | $6,250 |
| **652HR-1** | | M | | • | $6,660 |
| **655HR-1** | • | • | | • | $6,925 |
| **656HR-1** | | • | • | • | $7,740 |

**For complete Television product information, check box on the business return card in this catalog.**

# TEK PORTABLE FIBER OPTIC CABLE TESTERS



## FIBER OPTIC CABLE TESTERS

- Single-Mode and Multi-Mode Environments
- 825 nm to 1550 nm
- LCD Readout
- Accurate, Repeatable Measurements
- Optional Chart Recorder, Optional Recorder Output
- Digital Storage with Easy-To-View Waveform and Noise Reduction
- Two Selectable Pulse Widths (with Optional Pulse Widths on the OF151)
- Rugged and Portable—Operates from 12 Volt Vehicle System or Battery Pack

### TEKTRONIX PORTABLE FIBER OPTIC INSTRUMENTS

| Instrument Type | Type | Wavelength | Fiber |
|---|---|---|---|
| ***NEW*** OF235 | OTDR | 1300 nm/1550 nm | Singlemode |
| OF151 | OTDR | 1300 nm | Singlemode |
| OF152 | OTDR | 1300 nm | Multimode |
| OF150 | OTDR | 825 nm or 850 nm | Multimode |
| ***NEW*** OF192 | Bandwidth Test Set | 825 nm/850 nm/1300 nm | Multimode |

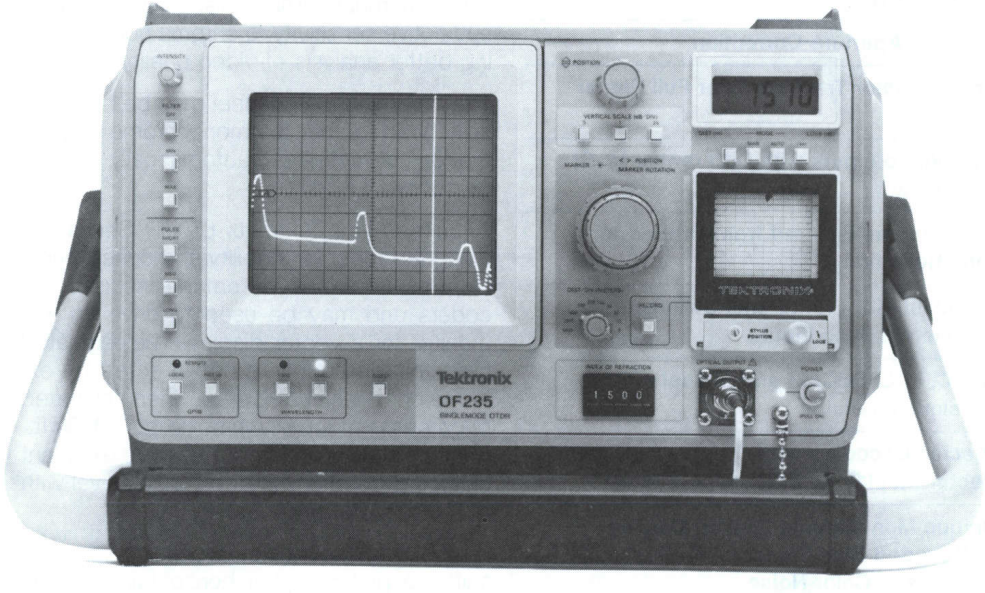
## *NEW* OF235

**Fiber Optic TDR**

GPIB IEEE-488

The OF235 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

- Dual Wavelength
- 1300 nm/1550 nm Switchable GPIB
- 3 Loss Measurement Modes
- Connectors Available: AT&T Biconic, FC, NEC, Diamond 3.5, Diamond 2.5, Radiall
- 0.25 dB/Div Vertical Scale
- 1 Meter Distance Resolution




### ORDERING INFORMATION

**OF235** Fiber Optic Time Domain Reflectometer **$29,500**

**OPTIONS**

| | |
|---|---|
| **Option 01** — XY1. | **+$300** |
| **Option 04** — Chart Recorder. | **+$1,050** |
| **Option 07** — Delete 1550 nm. | **−$7,000** |
| **Option 08** — Delete 1300 nm. | **−$4,000** |
| **Option 20** — AT&T Biconic Connector. | **NC** |
| **Option 22** — FC Connector. | **NC** |
| **Option 23** — NEC Connector. | **NC** |
| **Option 24** — Diamond Connector. | **NC** |
| **Option 25** — Radiall Connector. | **NC** |

**OF151** Fiber Optic Time Domain Reflectometer **$19,500**

**OPTIONS**

| | |
|---|---|
| **Option 01** — XY1 Output Module. | **+$300** |
| **Option 04** — Chart Recorder. | **+$1,050** |
| **Option 11** — LONG Pulsewidth 107 Meters. | **NC** |
| **Option 12** — SHORT Pulsewidth 17 Meters. | **NC** |
| **Option 20** — AT&T Biconic Connector. | **NC** |
| **Option 22** — FC Connector. | **NC** |

**OF152** Fiber Optic Time Domain Reflectometer **$18,500**

**OPTIONS**

| | |
|---|---|
| **Option 01** — XY1 Output Module. | **+$300** |
| **Option 04** — Chart Recorder. | **+$1,050** |
| **Option 20** — AT&T Biconic Connector. | **NC** |

**OF150** Fiber Optic Time Domain Reflectometer **$17,500**

**OPTIONS**

**Option 01** — XY1 Output Module. **+$300**
**Option 04** — Chart Recorder. **+$1,050**
**Option 05** — 850 nm (Nominal). **NC**
**Option 20** — AT&T Biconic Connector. **NC**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

## OPTIONAL ACCESSORIES (OF235, OF151, OF152, OF150)

**Fiber Adaptors:**

**FA-1** — Deutsch-Multimode Fiber. **$695**
**FA-2** — AT&T Biconic-Multimode Fiber. **$695**
**FA-3** — Diamond (3.5)-Singlemode Fiber. **$695**
**FA-4** — FC-Singlemode Fiber. **$695**
**FA-5** — AT&T Biconic-Singlemode Fiber. **$695**
**C-5C** — Camera. **$495**
**C-7** — Camera. **$595**
**Hard Case** — Transit. Order 016-0658-00 **$725**
**Soft Case** — Order 016-0659-00 **$100**
**Receptacle Connector, Optical** — Ten each. Order 013-0207-02 **$375**
**Chart Paper** — One Roll. Order 006-3618-00 **$9.25**
**Chart Paper** — 25 Rolls. Order 006-3618-01 **$210**
**Chart Paper** — 100 Rolls. Order 006-3618-02 **$695**
**Accessory Kit** — Deutsch Tools and Plugs. Order 015-0474-00 **$695**
**Sun Visor** — Order 016-0653-00 **$30**
**XY1 Output Module** **$350**
**Chart Recorder** — Order 016-0506-07 **$1,100**
**Cable Assembly, Diamond to AT&T Biconic** — Order 175-9708-00 **$495**
**Cable Assembly, Diamond to FC** — Order 175-9707-00 **$495**
**Cable Assembly, Diamond to Diamond** — Order 175-9695-00 **$495**

**SERVICE MANUALS**

**Board Level** — Order 070-5601-00 **$100**
**Component Level** — Order 070-5602-00 **$100**

A variety of training accessories are also available including workbooks, videotapes, etc.

Additional information available in the *OF150 Series Brochure* (request number 22-W-5847). Request copies at your local sales office.

The Tektronix three-year warranty applies to these products.

## *NEW* OF192

**Fiber Optic Bandwidth Test Set**

GPIB IEEE-488

The OF192 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Frequency Range (Automatic)**
**1 MHz to 1450 MHz**

**Attenuation Measurement Accuracy ±15dB**

**Connectors: AT&T Biconic, FC, Diamond, SMA**

**Temperature Operating Range**
**0°C to +50°C**

## ORDERING INFORMATION

**OF192** Fiber Optic Bandwidth Test Set **$32,000**

**Includes:** Ac power cord (161-0118-00); four calibration jumper cables (174-0043-00, 174-0045-00, 174-0047-00, 174-0049-00); operator handbook (070-5744-00).

**OPTIONS**

**Option 05** — 850NM TX Module. **+$3,000**
**Option 06** — 825NM TX Module. **+$3,000**
**Option 07** — 1300NM TX Module. **+$7,500**
**Option 20** — AT&T Biconic Connector. **NC**
**Option 21** — Diamond Connector. **NC**
**Option 22** — FC Connector. **NC**
**Option 23** — SMA Connector. **NC**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1**— Universal Euro 222 V/16A, 50 Hz.
**Option A2** — UK 240 V/13A, 50 Hz.
**Option A3** — Australian 240 V/10A, 50 Hz.
**Option A4** — North American 240 V/15A, 60 Hz.
**Option A5** — Switzerland 220 V/10A, 50 Hz.

## OPTIONAL ACCESSORIES (OF192)

**FA-2** — Fiber Adaptor (AT&T Biconic) **$695**
**FA-6** — Fiber Adaptor (FC) **$695**
**FA-7** — Fiber Adaptor (SMA) **$695**

## *NEW* Electrical/Optical Optical/Electrical Converters

The OT501/502/503 Transmitters and OR501/502 Receivers are designed to transmit and receive signals across fiber. The receivers can be used to convert most instruments to optical instruments (e.g., the optical scope).

Designed as a TM 500 plug-in, they may be used in any TM 500 mainframe.

**OT501/502/503 Transmitters**

| | OT501 | OT502 | OT503 |
|---|---|---|---|
| Wavelength | 825 ±15 nm | 850 ±10 nm | 1300 ±25 nm |
| FWHM* | <2 nm | | <4 nm |
| Output Power, Dc | +3 dBm | | 0 dBm |
| Mod Input | 50 Ω | | |
| Mod Input Level Max w/100% Mod | +20 dBm <0 dBm | | |
| Mod Freq Response | .03 to 1700 MHz | | .03 to 1500 MHz |
| Mod Flatness | ±1 dB (.05 to 1000 MHz) | | |
| | ±2 dB (.03 to 1700 MHz) | | ±5 dB (.03 to 1500 MHz) |

**OR501/502 Receivers**

| | OR501 | OR502 |
|---|---|---|
| Wavelength | 700 to 1500 nm | |
| Photo Element | Ge-APD | |
| Max Linear Input | −20 dBm | +10 dBm |
| Frequency Response | .03 to 1500 MHz ±2 dB .05 to 1000 MHz ±1 dB | |
| Noise Floor | ⩽−110 dBm/Hz | |
| Output 50 Ω | −15 dBm typical for −20 dBm optical input | −12 dBm typical −20 dBm optical input |
| Optical Attenuator | N/A N/A | 2.5 dB/step (Nom) 37.5 dB (Max) |

* *Full wave half maximum.*

## ORDERING INFORMATION

**OT501** — 825 nm E/O Converter. **$5,900**
**OT502** — 850 nm E/O Converter. **$5,900**
**OT503** — 1300 nm E/O Converter. **$9,500**
**OR501** — O/E Converter. **$4,300**
**OR502** — O/E Converter. **$6,500**

**OPTIONS**

**Option 20** — AT&T Biconic Connector. **NC**
**Option 21** — Diamond 3.5 Connector. **NC**
**Option 22** — FC Connector. **NC**
**Option 23** — SMA Connector. **NC**

# DATA COMMUNICATIONS ANALYZERS FROM TEKTRONIX: SOLVING PROBLEMS IN A COMPLEX NETWORK WORLD

**High Speed. Up to 72 kbps, all Modes**

**Upload/Download. Uploads Data, Downloads Programs between Analyzer and Host or Analyzer to Analyzer.**

**NonVolatile Memory. Automatically Retains all Programs, Set-ups and Captured Data.**

**Multiple Triggers. Multiple String Triggers in the 836, and all Instruments Trigger on Selected Control Line Changes, Error Conditions or Character Strings, Both Masked and Unmasked.**

**Data Compression. Prevents Buffer from Filling up with Idle Frames in HDLC.**

**Application RAM and ROM Packs. The 830M Series Memory Packs Provide Mass Storage (RAM) of Data and Programs plus Application Programs (ROM). The 830L Series Library Packs Allow Multiple Selection of Application Programs through User-Selectable ROM Banks. The ROM Development Aid (834RDA/830RDA) Gives Users the Ability to Automate and Extend the Capabilities of the Analyzers. Other Application ROM Packs Contain Software to Expand the Analyzers and Preprogrammed Test Routines Dedicated to Specific Applications.**

**Products are Rackmountable. Standard Instruments are Lightweight, Rugged and Portable.**

## ORDERING INFORMATION

| | |
|---|---|
| **836** Programmable Data Communications Analyzer | **$4,650** |
| **835** Programmable Data Communications Analyzer | **$3,350** |
| **834** Programmable Data Communications Analyzer | **$2,450** |
| **Rackmount Version Available** (835/836 only) | **+$300** |

### OPTIONS

| | |
|---|---|
| **Option 02** — Current Loop Interface. | **+$325** |
| **Option 03** — RS-449 (RS-422/RS-423) Interface. | **+$750** |
| **Option 04** — MIL-STD-188C Interface. | **+$350** |
| **Option 05** — Two Wire Direct Interface. | **+$395** |
| **Option 06** — V.35 Interface. | **+$800** |

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### APPLICATION AND MASS STORAGE PACKS

| | |
|---|---|
| **830L01** — Two Bank Library Pack (ROM)*[1]. | **$255** |
| **830L02** — Four Bank Library Pack (ROM)*[1]. | **$400** |
| **830L03** — Eight Bank Library Pack (ROM)*[1]. | **$550** |
| **830M01** — Memory Pack (1 Bank 16 k RAM/ No ROM)*[1]. | **$350** |
| **830M02** — Memory Pack (1 Bank 16 k RAM/ 1 Bank 16 k ROM)*[1]. | **$400** |
| **830M03** — Memory Pack (1 Bank 16 k RAM/ 4 Banks 16 k ROM)*[1]. | **$600** |
| **830M04** — Memory Pack (2 Banks 16 k RAM/ No ROM)*[1]. | **$380** |
| **830M05** — Memory Pack (2 Banks 16 k RAM/ 1 Bank 16 k ROM)*[1]. | **$450** |
| **830M06** — Memory Pack (2 Banks 16 k RAM/ 4 Banks 16 k ROM)*[1]. | **$700** |
| **830M07** — Memory Pack (3 Banks 16 k RAM/ No ROM)*[1]. | **$450** |
| **830M08** — Memory Pack (3 Banks 16 k RAM/ 1 Bank 16 k ROM)*[1]. | **$500** |
| **830M09** — Memory Pack (3 Banks 16 k RAM/ 4 Banks 16 k ROM)*[1]. | **$750** |

### Software Options Available with Above*[1]

| | |
|---|---|
| **Option 01** — 830S01 Asynchronous. | **$140** |
| **Option 02** — 830S02 Bisync (EBCDIC). | **$175** |
| **Option 03** — 830S03 Link Test. | **$195** |
| **Option 04** — 830S04 HDLC/X.25. | **$275** |
| **Option 06** — 830S06 Bisync (ASCII). | **$175** |
| **Option 10** — 830S10 SDLC/SNA (FID2). | **$275** |
| **Option 11** — 830S11 Extended Monitor. | **$250** |
| **Option 13** — 830S13 SDLC/SNA (FID3). | **$275** |
| **Option 1A** — 830SDA ROM Development Aid. | **$275** |
| **Option 2A** — 830SDA with Option 01. | **$275** |

*[1] *For use with the 836 and 835 only.*

| | |
|---|---|
| **834RDA** — ROM Development Aid. | **$450** |
| **830RDA** — ROM Development Aid. | **$450** |
| **834R01** — Asynchronous ROM Pack. | **$280** |
| **830R01** — Asynchronous ROM Pack. | **$280** |
| **834R02A** — Bisynchronous (EBCDIC) ROM Pack. | **$350** |
| **834R03A** — Link Test ROM Pack. | **$370** |
| **830R03** — Link Test ROM Pack. | **$370** |
| **834R04** — HDLC/X.25 ROM Pack. | **$450** |
| **834R05** — Extended Instruction ROM Pack. | **$175** |
| **834R06** — Bisynchronous (ASCII) ROM Pack. | **$350** |
| **834R07** — PARS/IPARS ROM Pack. | **$375** |
| **830R07** — PARS/IPARS ROM Pack. | **$375** |
| **834R10** — SDLC/SNA (FID2) ROM Pack. | **$450** |
| **830R10** — SDLC/SNA (FID2) ROM Pack. | **$450** |
| **834R11** — Extended Monitor ROM Pack. | **$425** |
| **834R13** — SDLC/SNA (FID3) ROM Pack. | **$450** |
| **830R13** — SDLC/SNA (FID3) ROM Pack. | **$450** |
| **Option 12** — (834R02A, 834R06, 834R10, 834R13 ROM Packs Only) Download with ATT Application. | **+$60** |

## OPTIONAL ACCESSORIES

| | |
|---|---|
| **Service Manual** — Order 070-5600-00 | **$100** |
| **Carrying Case** — Order 016-0672-00 | **$80** |
| **Shielded "T" Cable** — Order 175-9709-00 | **$75** |
| **RS-449 Interface Adaptor** — (A6741) | **$750** |
| **Two-Wire Interface Adaptor** — (A6742) | **$395** |
| **RS-232 V.24 Tri-State Break-Out Box** — (A6743) | **$265** |
| **V.35 Interface Adaptor** — (A6744) | **$800** |
| **Current Loop Interface Adaptor** — Order 015-0361-00. | **$350** |

**New accessories continually being introduced. Please check with sales engineer at local sales office.**

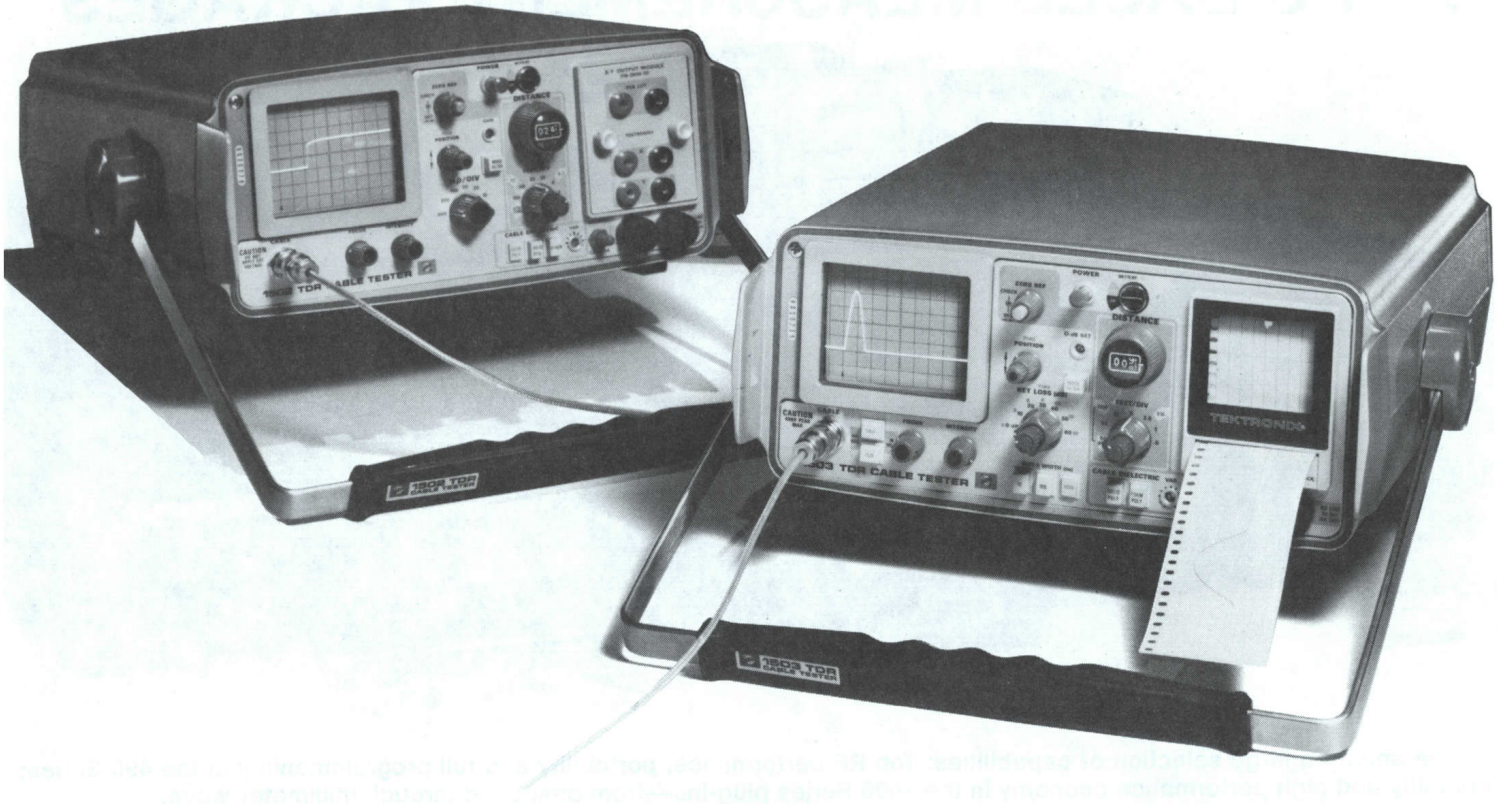
**A variety of training accessories are also available including workbooks, videotapes, etc.**

**Additional information available in the** *830 Series Brochure* (request number 22-W-5910) and in the *830 Series Selection Guide* (request number 22-W-5901). Request copies at your local sales office.

## LOGISTICS INFORMATION

**For logistics data, see Tektronix Logistics Data Book.**

# TEKTRONIX METALLIC CABLE TESTERS: ACCURATE TIME DOMAIN REFLECTOMETRY FOR FIELD MAINTENANCE, LONG-RANGE AND SHORT-RANGE



## 1502/1503

**Portable. Battery-Powered, Self-Contained, Lightweight**

**Rugged. Meets MIL-T-28800, Type III, Class 3, Style A**

**Versatile. Tests any Type Paired-Conductor and Coax Cable**

**Easy to Use. Produces Results with Minimal Operator Training**

The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. It uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet.

The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications. It provides high-energy, ½-sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet.

## ORDERING INFORMATION

**1502** Short Range TDR Cable Tester **$6,200**

**1503** Long Range TDR Cable Tester **$5,200**

**Option 01** — (1503 Only) Distance Cal. **+$375**

**Option 02** — (1502 Only) With Static Suppressor. **+$150**

**Option 04** — With Cable Tester Recorder. **+$1,050**

**Option 05** — With Cable Tester Metric Version. **NC**

**Option 76** — GM (P7) Phosphor. **+$35**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES (1502)

**Chart Recorder** — Order 016-0506-04 **$1,100**

**Chart Paper** — One Roll. Order 006-1658-01 **$7.50**

**Chart Paper** — 100 Roll Case. Order 006-1658-02 **$550**

**Accessory Pouch** — Order 016-0351-00 **$25**

**Impedance Adaptor** —
50/75 Ω. Order 017-0091-00*[1] **$185**
50/93 Ω. Order 017-0092-00*[1] **$185**
50/125 Ω. Order 017-0090-00*[1] **$185**

*[1] *Should be purchased with following two parts:*

**Connector, BNC Female-to-GR** — Order 017-0063-00 **$43**

**Connector, BNC Male-to-GR** — Order 017-0064-00 **$75**

### OPTIONAL ACCESSORIES (1503)

**Chart Recorder** — Order 016-0506-06 **$1,100**

**Chart Paper** — One Roll. Order 006-1658-01 **$7.50**

**Chart Paper** — 100 Roll Case. Order 006-1658-02 **$550**

**Isolation Network** — (For balanced line). Order 013-0169-00 **$265**

**Adaptor Cables (BNC-to-Clips)** —
Nine foot. Order 012-0671-02 **$75**
30 foot. Order 012-0671-03 **$85**

**Direct Current Adaptor with Filter** — 25 foot cord (for use with standard 12 V automobile lighter plug with negative ground). Order 015-0327-00 **$250**

**Pulse Inverter** — Order 015-0495-00 **$75**

A variety of training accessories are also available including workbooks, videotapes, etc.

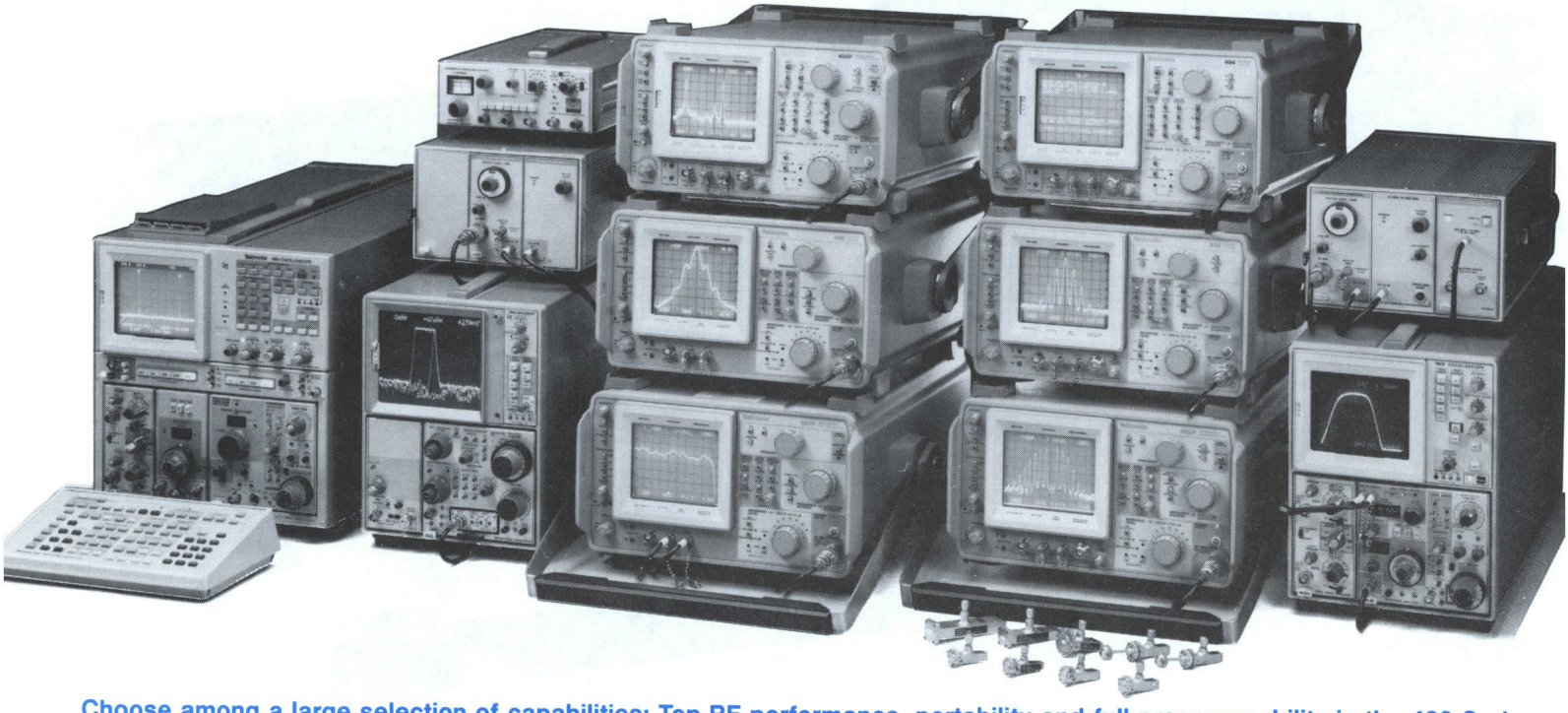
Additional information available in the *1500 Series TDR Cable Testers Brochure* (request number 27-AX-3004-4). Request copies at your local sales office.

Prices, terms and conditions may change without notice.

### LOGISTICS INFORMATION

**For logistics data, see Tektronix Logistics Data Book.**

# SPECTRUM ANALYZERS, SWEPT FREQUENCY SYSTEMS & IBM PC BASED MEASUREMENT PACKAGES



**Choose among a large selection of capabilities: Top RF performance, portability and full programmability in the 490 Series; versatility and high performance economy in the 7000 Series plug-ins—from baseband through millimeter-wave.**

**Enhance your productivity, measurement repeatability and utility with TekSPANS—the *NEW* Family of Spectrum Analyzer Applications Software—available for IBM PC, Tek or HP controllers. See page 158.**

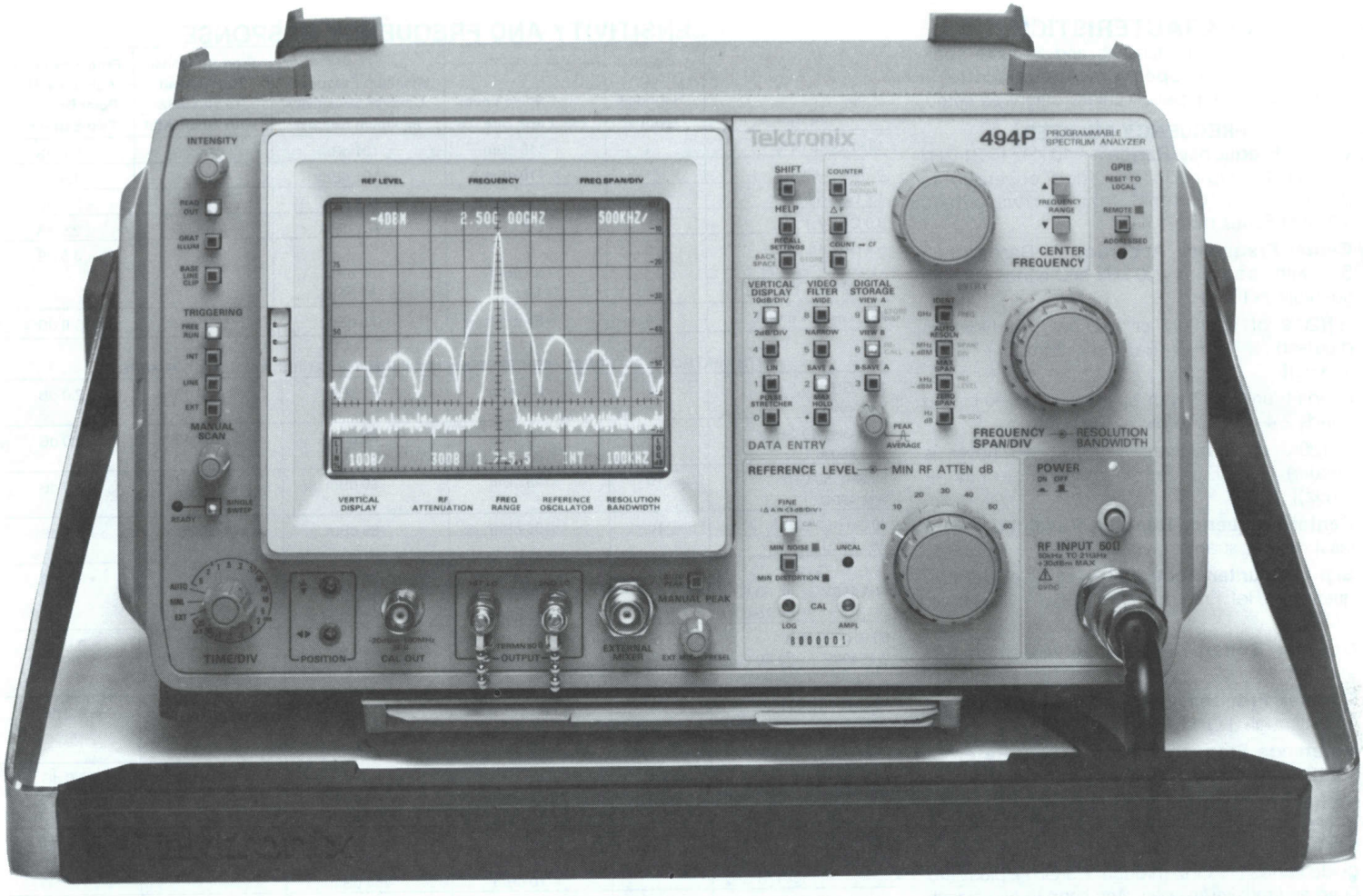


## PRODUCT SELECTION GUIDE

| | 7L5 | 7L12 | 7L14 | 496/496P | 7L12 Opt 39 | 7L14 Opt 39 | 492/492P | 494/494P |
|---|---|---|---|---|---|---|---|---|
| **Frequency Range** | 20 Hz to 5 MHz | 100 kHz to 1.8 GHz | 10 kHz to 1.8 GHz | 1 kHz to 1.8 GHz | 100 kHz to 2.5 GHz | 1 kHz to 2.5 GHz | 50 kHz to 220 GHz | 10 kHz to 325 GHz |
| **Minimum Resolution** | 10 Hz | 300 Hz | 30 Hz | 30 Hz | 300 Hz | 30 Hz | 100 Hz | 30 Hz |
| **Average Noise Level: (1 kHz BW)** | −133 dBV | −113 dBm | −115 dBm | −115 dBm | −113 dBm | −115 dBm | −110 dBm | −110 dBm |
| **Amplitude Measurement Range:** | +8 dBV to −148 dBV | +30 dBm to −115 dBm | +30 dBm to −130 dBm | +30 dBm to −126 dBm | +30 dBm to −115 dBm | +30 dBm to −130 dBm | +30 dBm to − 118 dBm | +30 dBm to −121 dBm |
| **GPIB Capability:** Semiautomatic w/7854 | ✓ | ✓ | ✓ | | ✓ | ✓ | | |
| Full | | | | ✓ 496P Only | | | ✓ 492P Only | ✓ 494P Only |
| **Tracking Generator:** Opt 25 | ✓ | | | | | | | |
| TR 502 | | ✓ | ✓ | | ✓*1 | ✓*1 | | |
| TR 503 | | | | ✓*1 | | | ✓ | ✓ |
| **Frequency Accuracy:** | ±(5 Hz +2 x $10^{-6}$ Dot Freq) | ±(8 MHz +1% of Dial) | ±(5 MHz +2% of Span) | ±(5 MHz +2% of Span) | ±(8 MHz +1% of Dial) | ±(5 MHz +2% of span) | ±(0.2% or 5 MHz +2% Span) | ±[(2% Span or RES BW) +(CF X REF Error) +(2N + 25 Hz)] |
| **Page** | 170 | 168 | 166 | 159 | 169 | 167 | 162 | 155 |
| **Prices Begin At** | *2 | *2 | *2 | $24,350/$28,950 | *2 | *2 | $21,750/$30,000 | $40,425/$44,650 |

*1 *To 1.8 GHz.*
*2 *Dependent on 7000 Series mainframes. See page 190.*

**Waveguide Mixers from 18 GHz to 325 GHz, see page 165.**
**Tracking Generators, see page 172.**
**Accessories, see page 174.**




# 494P/494

GPIB IEEE-488 The 494P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Built-In Frequency Counter to 325 GHz**

**HELP Manual in ROM**

**Nonvolatile Memory Storage**

**Keypad Data Entry**

**Direct Plot Capability**

**Alternate Language Options**

**GPIB/Fully Programmable (494P)**

**Full Three Year Warranty**

**More accuracy, convenience, performance, and value**

The Tek 494 and fully programmable 494P are altogether advanced, innovative spectrum analyzers offering portability, ease of use and unprecedented versatility. They deliver maximum utility and benefits at a surprisingly reasonable cost.

**Counter center frequency accuracy, zero long-term drift, superior range and resolution in a compact, portable package**

The 494 offers the widest amplitude calibrated frequency range of any spectrum analyzer available: 10 kHz to 21 GHz in coax, and 325 GHz using one or more of ten Tek waveguide mixers.

A 4 GHz signal can be measured to within 41 Hz with 1 Hz readout resolution 30 minutes after turn on. And the 494's zero drift will insure long-term measurement repeatability on that frequency.

You get 30 Hz resolution bandwidth to 60 GHz, 100 Hz resolution bandwidth to 220 GHz and 1 kHz bandwidth to 325 GHz with excellent sensitivity and low phase noise. Popular features common to other 490 Series spectrum analyzers are standard on the 494, including digital storage, manual to programmable convertibility, and environmentalization per MIL-T-28800C, Type III, Class 3, Style C.

An exclusive pushbutton ***HELP*** mode makes the 494 accessible to operators of widely varying skills and experience. At the touch of a button or twist of a knob the 494 tells you what to expect from nearly every control—in plain English. Plus optional French, German, or Spanish. Pull-out reference cards supply an additional level of detail. Having answers available at your fingertips minimizes training time and reduces complexity.

**Center frequency, span/division, amplitude scaling and reference level selected either by μP-aided three-knob operation or direct pushbutton entry**

In push-button mode, variables can be set to nonstandard values, i.e., 7 dB/div vertical mode or 9.2 kHz/div frequency span.

Nonvolatile memory retains up to ten set-ups and nine displays—for rapid measurements and easy data comparison. One memory location stores on-screen settings to quickly bring the analyzer back if power is turned off.

The fully programmable 494P provides easy-to-implement automated measurements. The 494P is straightforward to interface to our GPIB controllers...or yours. If you want to free your controller but still get graphics output, a convenient front panel ***PLOT*** button will send display data to a plotter.

Now increase your ATE capabilities with the *NEW* TekSPANS general RF applications software in IBM PC, HP or Tek controller versions. See page 158.

In strong testimony of the incomparable reliability of the 494 and 494P, Tek offers the first spectrum analyzer three year warranty. Beyond the first three years of warranty coverage, Tek will extend your service coverage for two years providing all your calibration and maintenance needs for the first five years.

## CHARACTERISTICS

The following characteristics and features apply to the 494/494P Spectrum Analyzer after a 30-minute warmup period unless otherwise noted.

### FREQUENCY RELATED

**Center Frequency Range —** 10 kHz to 21 GHz standard; amplitude specified coverage to 325 GHz with optional Tektronix waveguide WM 490 Series mixers.

**Center Frequency Accuracy —** Bands 1 and 5-12 with span/div >200 kHz and bands 2-4 with span/div >100 kHz.

±[(20% of span/div or res bw, whichever is greatest) + (CF x Ref Freq Error) + (N x 15 kHz)].

Bands 1 and 5-12 with span/div ≤200 kHz and Bands 2-4 with span/div ≤100 kHz.

±[(20% of span/div or res bw, whichever is greater) + (CF x Ref Freq Error) + (2N + 25 Hz)].

**Center Frequency Readout Resolution —** At least 10% of span/div.

**Signal Counter Accuracy —** ±[(Counter Frequency x Ref Freq Error) + (10 + 2N) Hz + 1 LSD)].

**Counter Sensitivity —** Center Screen S/N ≥20 dB.

**Counter Frequency Readout Resolution —** 1 Hz through 1 GHz.

**Reference Frequency Error (Aging Rate) —** 1 x $10^{-9}$/day, 1 x $10^{-7}$/year.

**Frequency Span/Division Range —** 50 Hz/div to 500 MHz/div in coaxial bands (10 kHz through 21 GHz) and 50 Hz/div to 10 GHz/div in waveguide bands (18 GHz through 325 GHz), plus zero span and maximum span. Any span to two significant digits (within 50 Hz and up to 10 GHz) can also be selected with the Data Entry Keyboard.

**Frequency Span/Division Accuracy —** Within 5% of the selected span/div over the center eight division of the ten division CRT display.

**Resolution Bandwidth (6 dB) —** 30 Hz then 100 Hz to 1 MHz in decade steps plus auto. Accuracy: Within 20%.

**Resolution Shape Factor (60 dB/6 dB) —** 7.5:1 or less, 100 Hz through 1 MHz and 15:1 or less for 30 Hz.

**Residual FM (After One Hour Warmup) —** Bands 1 and 5-12 with span/div >200 kHz, and bands 2-4 with span/div >100 kHz: ≤(7 kHz) N total excursion in 20 ms.

Bands 1 and 5-12 with span/div ≤200 kHz, and bands 2-4 with span/div ≤100 kHz: ≤(10 + 2N) Hz total excursion in 20 ms.

**Long-Term Drift (at Constant Temperature and Fixed Center Frequency and After One-Hour Warmup) —** Bands 1 and 5-12 with span/div >200 kHz, and bands 2-4 with span/div >100 kHz: ≤(5 kHz) N per minute of sweep time.

Bands 1 and 5-12 with span/div ≤200 kHz, and Bands 2-4 with span/div ≤100 kHz: ≤50 Hz per minute of sweep time.

**Noise Sidebands —** At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth or less).

## SENSITIVITY AND FREQUENCY RESPONSE

| Freq Range | LO Harmonic Number | Ave Noise Level For 1 kHz Res BW | Minimum Frequency Counter Sensitivity Minimum Res BW | Freq Response Referenced To 100 MHz With 10 dB Attn | Freq Response About the Mid Point Between Two Extremes |
|---|---|---|---|---|---|
| 10 kHz-1.8 GHz | 1 | −110 dBm | −101 dBm | ±3.0 dB | ±2.0 dB |
| 50 kHz-1.8 GHz | 1 | −110 dBm | −101 dBm | ±2.5 dB | ±1.5 dB |
| 1.7 GHz-5.5 GHz | 1 | −110 dBm | −101 dBm | ±3.5 dB | ±2.5 dB |
| 3.0 GHz-7.1 GHz | 1 | −110 dBm | −101 dBm | ±3.5 dB | ±2.5 dB |
| 5.4 GHz-18.0 GHz<br>(to 12 GHz)<br>(12 GHz-18 GHz) | 3 | <br>−95 dBm<br>−90 dBm | <br>−86 dBm<br>−81 dBm | ±4.5 dB | ±3.5 dB |
| 15.0 GHz-21.0 GHz | 3 | −85 dBm | −76 dBm | ±6.5 dB | ±5.0 dB |
| **WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WM 490 SERIES WAVEGUIDE MIXERS** | | | | | |
| 18.0 GHz-26.5 GHz<br>**WM 490K** | 6 | −100 dBm | −91 dBm | ±6.0 dB | ±2.0 dB |
| 26.5 GHz-40 GHz<br>**WM 490A** | 10 | −95 dBm | −86 dBm | ±6.0 dB | ±2.0 dB |
| 33 GHz-50 GHz<br>**WM 490Q** | 10 | −95 dBm | −86 dBm | ±6.0 dB | ±2.0 dB |
| 40 GHz-60 GHz<br>**WM 490U** | 10 | −95 dBm | −86 dBm | ±6.0 dB | ±2.5 dB |
| 50 GHz-75 GHz*<br>**WM 490V** @ 50 GHz<br>@ 75 GHz | 15 | <br>−95 dBm<br>−90 dBm | <br>−86 dBm<br>−81 dBm | ±6.0 dB | ±3.0 dB |
| 60 GHz-90 GHz*<br>**WM 490E** @ 60 GHz<br>@ 90 GHz | 15 | <br>−95 dBm<br>−85 dBm | <br>−89 dBm<br>−79 dBm | ±6.0 dB | ±3.0 dB |
| 75 GHz-110 GHz*<br>**WM 490W** @ 75 GHz<br>@ 110 GHz | 23 | <br>−90 dBm<br>−80 dBm | <br>−84 dBm<br>−74 dBm | ±6.0 dB | ±3.0 dB |
| 90 GHz-140 GHz*<br>**WM 490F** @ 90 GHz<br>@ 140 GHz | 23 | <br>−85 dBm<br>−75 dBm | <br>−79 dBm<br>−69 dBm | ±6.0 dB | ±3.0 dB |
| 110 GHz-170 GHz*<br>**WM 490D** @ 110 GHz<br>@ 170 GHz | 37 | <br>−80 dBm<br>−70 dBm | <br>−74 dBm<br>−64 dBm | ±6.0 dB | ±3.0 dB |
| 140 GHz-220 GHz*<br>**WM 490G** @ 140 GHz<br>@ 220 GHz | 37 | <br>−75 dBm<br>−65 dBm | <br>−69 dBm<br>−59 dBm | ±6.0 dB | ±3.0 dB |
| 220 GHz-325 GHz*<br>**119-1728-00** @ 220 GHz<br>@ 325 GHz | 56 | <br>−65 dBm<br>−50 dBm | <br>−50 dBm<br>−35 dBm | ±6.0 dB | ±3.0 dB |

** Typical values and with frequency response indicated over any 5 GHz range.*

### AMPLITUDE RELATED

**Reference Level Range (Full Screen, Top of Graticule) —** −117 dBm to + 40 dBm (+40 dBm, includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.

**Vertical Display Modes —** 10 dB/div, 2 dB/div, and linear. Any integer between 1-15 dB/div can also be selected with the data entry keyboard.

**Reference Level Steps —** 10 dB, 1 dB and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when minimum noise is active) unless minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each reference level change below −30 dBm (−20 dBm when minimum noise is active).

**Display Dynamic Range —** 80 dB at 10 dB/div, 16 dB at 2 dB/div and eight division in linear mode.

**Reference Level Accuracy —** Accuracy is a function of the characteristics listed below.

**Calibrator:** (Cal out) See output signal characteristics on next page.

**Input Attenuator Accuracy:** Dc to 1.8 GHz: 0.5 dB/10 dB, 1 dB max accumulative. 1.8 GHz to 18 GHz: 1.5 dB/10 dB, 3 dB max accumulative. 18 GHz to 21 GHz: 3.0 dB/10 dB, 6 dB max accumulative.

**Frequency Response:** See Frequency Response Table on this page.

**Display Amplitude Accuracy:** ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin Mode is 5% of full scale.

**Resolution Bandwidth Gain Variation:** ±0.4 dB, after Cal routine has been executed and with respect to the 1 MHz filter.

**IF Gain Variation:** Gain steps are monotonic (same direction) with the following limits: Within 0.2 dB/dB to a maximum of 0.5 dB/9 dB, except at the decade transitions of −19 dBm to −20 dBm, −29 dBm to −30 dBm, −39 dBm to −40 dBm, −49 dBm to −50 dBm, and −59 dBm to −60 dBm, where an additional 0.5 dB can occur for a total of 1.0 dB per decade. Maximum deviation over the 97 dB range is within ±2 dB.

## SPURIOUS RESPONSES

**Residual (No Input Signal Referenced to Mixer Input) —** −100 dBm or less. Fundamental mixing Bands 1-3.

**Harmonic Distortion (cw Signal Minimum Distortion Mode) —** Typically −60 dBc for −40 dBm signal in the minimum distortion mode to 21 GHz. At least −100 dBc for preselected bands 1.7 GHz to 21 GHz.

**Third-Order Intermodulation Distortion (Minimum Distortion Mode) —** At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 GHz to 21 GHz for preselected bands.

**LO Emissions (No RF Attenuation) —** −70 dBm maximum to 21 GHz.

## INPUT SIGNAL

**RF Input —** Type N female connector.

**Input Impedance —** 50 Ω.

**Maximum VSWR*[1] with ≥10 dB Attenuation**

| Frequency Range | Typical | Specified Maximum |
|---|---|---|
| Dc to 2.5 GHz | 1.2:1 | 1.3:1 |
| 2.5 GHz to 6.0 GHz | 1.5:1 | 1.7:1 |
| 6.0 GHz to 18 GHz | 1.9:1 | 2.3:1 |
| 18 GHz to 21 GHz | 2.7:1 | 3.5:1 |
| 50 kHz to 2.5 GHz | 1.9:1 | |
| 2.5 GHz to 6.0 GHz | 1.9:1 | |
| 6.0 GHz to 18.0 GHz | 2.3:1 | |
| 18.0 GHz to 21.0 GHz | 3.0:1 | |

*[1] *At Type N female connector to internal mixer*

**Input Level (Optimum Mixer Level for Minimum Distortion Linear Operation) —** −30 dBm (minimum distortion control setting); 1 dB gain compression −23 dBm.

**Optimum Mixer Level for Minimum Noise Display Dynamic Range Enhanced Operation —** −20 dBm (minimum noise control setting); 1 dB gain compression −18 dBm.

**External Reference Frequency —** 1 MHz, 2 MHz, 5 MHz or 10 MHz ±5 ppm (minimum).
Waveshape: Sinewave, ECL, TTL duty cycle 40%-60%.
Input Impedance: 50 Ω ac, 500 Ω dc.
Power: −15 dBm to +15 dBm.

**Maximum Safe Input Level (RF Attenuation at Zero dB) —** +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

## OUTPUT SIGNAL

**Calibrator —** (Cal Out) −20 dBm ±0.3 dB, 100 MHz x reference frequency error.

**1st and 2nd LO —** Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm; 2nd LO −22 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

**Vertical Out —** Provides 0.5 V ±5% of signal/ div of video above and below the center line.

**Horizontal Out —** Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

**Pen Lift —** TTL, +5 V nominal to lift pen.

**IF Out —** Output of the 10 MHz IF. Level is approximately −5 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

**Probe Power —** Provides operating voltages (+5 V, +15 V, −15 V, and ground) for active probes.

**IEEE Standard 488-1978 Interface Function Subsets Implemented (494P) —** Source Handshake: SH1. Acceptor Handshake: AH1. Talker: T5. Listener: L3. Service Request: SR1. Remote/Local: RL1. Parallel Poll: PP1. Device Clear: DC1. Device Trigger: DT1. Controller: C0.

## GENERAL CHARACTERISTICS

For details see page 164.

## ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C Type III, Class 3, Style C. For Details see page 160.

## ORDERING INFORMATION

**494 Spectrum Analyzer** **$42,175**

**Includes:** Diplexer assembly (015-0385-00); 6 ft N to N connector 50 Ω coax cable, (012-0114-00); N male to BNC female adaptor (103-0045-00); 18 in BNC to BNC connector, 50 Ω coax cable (012-0076-00); CRT mesh filter (378-0726-01); two 4 A fast blow fuse (159-0017-00); 115 V power cord (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); blue CRT light filter (378-0115-00); operator manual (070-4418-00); operator handbook (070-4419-00); service manual, volume 1 (070-4416-00); service manual, volume 2 (070-4417-00).

**494P Spectrum Analyzer** **$46,400**

**Includes:** In addition to the above a 2 m, double shielded GPIB cable (012-0630-03); programmer manual (070-4415-00).

### OPTIONS (494/494P)

**Option 08 —** Delete External Mixer Capability. Deletes internal switching, front panel connector and external diplexer to connect and use external wavequide mixers. Limits frequency range to 10 kHz to 21 GHz (coaxial input). **−$1,750**

**Option 12 —** Help Mode Text. CRT prompts selectable between German and English. Pull-out reference cards in German. **+$200**

**Option 13 —** Help Mode Text. CRT prompts selectable between French and English. Pull-out reference cards in French. **+$200**

**Option 14 —** Help Mode Text. CRT prompts selectable between Spanish and English. Pull-out reference cards in Spanish. **+$200**

**Option 20 —** General Purpose 12.4 GHz to 40 GHz Waveguide Mixer Set. (12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz, and 26.5 GHz to 40 GHz) and hardware. **+$900**

**Option 21 —** High Performance 18 GHz to 40 GHz Waveguide Mixer Set. (18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz) and hardware. **+$2,525**

**Option 22 —** High Performance 18 GHz to 60 GHz Waveguide Mixer Set. (18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, and 40 GHz to 60 GHz) and hardware. **+$4,250**

**Option 30 —** Rackmount. 19 inch rack width with front panel input/outputs. See page 161. **+$790**

**Option 31 —** Rackmount. 19 inch rack width with rear panel input/output capability. See page 161. **+$840**

**Option 32 —** Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration. See page 161. **+$940**

**Option 41 —** Digital Radio. Provides wider bandwidth preselector, 30 Hz video filter with 100 kHz resolution bandwidth and 5 MHz span/div optimized for 6 GHz and 11 GHz D/R. **+$450**

**Option 42 —** 110 MHz IF Output. Provides 5 MHz bandwidth at 6 dB points. **+$1,500**

**Option 45 —** (494P only) MATE/CIIL. **$4,995**

### CONVERSION KIT

**494 to 494P —** Conversions are made by your nearest Tektronix Service Center.
Order 040-1140-01 **$5,300**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1 —** Universal Euro 220 V/16 A, 50 Hz.
**Option A2 —** UK 240 V/13 A, 50 Hz.
**Option A3 —** Australian 240 V/10 A, 50 Hz.
**Option A4 —** North American 240 V/15 A, 60 Hz.
**Option A5 —** Switzerland 220 V/10 A, 50 Hz.

### *WARRANTY-PLUS* SERVICE PLAN

SEE PAGE 457

**M1 —** (494) 2 Calibrations. **+$695**
**M1 —** (494P) 2 Calibrations. **+$715**
**M2 —** (494) +2 Years Service. **+$1,330**
**M2 —** (494P) +2 Years Service. **+$1,350**
**M3 —** (494) 4 Calibrations +2 Years Service. **+$2,725**
**M3 —** (494P) 4 Calibrations +2 Years Service. **+$2,785**
**M4 —** (494) 5 Calibrations. **+$1,590**
**M4 —** (494P) 5 Calibrations. **+$1,630**
**M5 —** (494) 9 Calibrations +2 Years Service. **+$4,145**
**M5 —** (494P) 9 Calibrations +2 Years Service. **+$4,240**

## OPTIONAL ACCESSORIES

**TR 503 Tracking Generator —** See page 172. **$6,620**

**Microwave Comb Generator TM 500 Series Compatible —** Order 067-0885-00 **$1,800**

**75 Ω to 50 Ω Minimum Loss Pad —** Order 011-0112-00 **$60**

**Dc Block N to N —** Order 015-0509-00 **$250**

**P6201 FET Probe to 900 MHz —** Order 010-6201-01 **$1,220**

**1405 TV Sideband Adaptor —** 525/60 Markers. See page 173. **$5,780**

**TV Trigger Synchronizer —** Order 015-0261-01 **$450**

**Hard Case (Transit) —** Order 016-0658-00 **$725**

**Soft Case —** Order 016-0659-00 **$100**

**Rear Panel Protective Cover —** Order 337-3274-00 **$5**

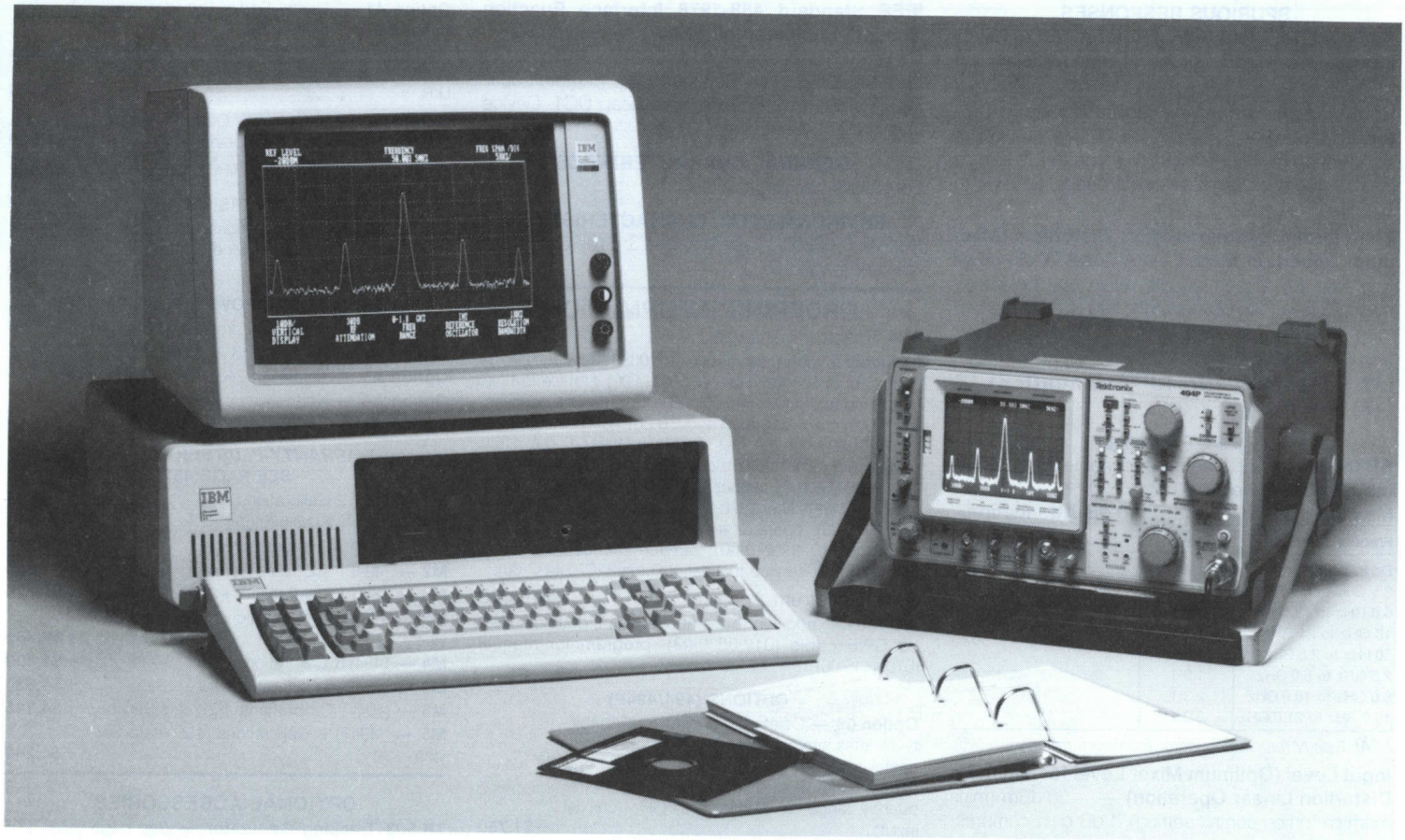
**Lab Cart —** K213. (See page 424.) **$595**

**Camera —** C-5C. (See page 416.) **$495**

*Note: 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras.*

### PERIPHERAL PRODUCTS FOR 494P SPECTRUM ANALYZER

**4041** System Controller (See page 298.) **$3,995**
**4105A** Color Terminal (See page 58.) **$3,495**
**4695** Color Graphics Copier (See page 76.) **$1,595**




# *NEW* TekSPANS® Software (GRASP®)

**_NEW_ TekSPANS Software Family to Automate Spectrum Analysis with a Choice of Controllers**

**Value Packed Spectrum Analyzer Software Expands the Utility of Your IBM PC and Compatibles**

**Highly Versatile Software Package Links PC to IEEE Bus**

**Bundled Packages Including Spectrum Analyzers, PC Interface and Application Software**

**Easy, Menu Driven Operation for First Time Users**

**Multiple Site/Remote Site Monitoring for RF Equipment**

Tek's GRASP (General RF Applications Software Package) is the first in a family of spectrum analyzer software packages called TekSPANS. GRASP is designed to capitalize on the power of the 490 Series programmable spectrum analyzers and a choice of controllers such as Tek's 4041, IBM PCs and compatibles, and HP Series 200.

Integration of the user's routines into TekSPANS software is very simple, and means that there is now an opportunity to match measurement needs and applications with the right mix of hardware/software and support.

The implementation of the GRASP software package helps improve the accuracy, repeatability, and speed of your measurements. The data logging capability enhances your ability to document, store, retrieve, and manipulate data derived from your test devices. And the front panel setup streamlines the measurement task.

This highly versatile software package offers many applications/utility routines which are selected through easy menu-driven operation. Even a nontechnical operator has immediate access to operations such as swept frequency measurements, identifying true signals from false responses, and performing signal analysis, including measurements of harmonic distortion and signal-to-noise ratio.

From GRASP's main menu, a user selects among any of the submenus for measurements, filter tests, signal search routines, waveform operations and utilities. Selections are made by simply pressing the appropriate function key shown on the screen. Prompts guide the user through each measurement task.

For example, users can utilize a cursors routine for the 490P display on their terminal screen. It calculates and displays both the absolute amplitude and frequency of one or two marked signals plus the relative amplitude and frequency difference between two markers. The cursors are used to select the points of interest on the display.

The software enables even first-time users to simplify and automate many complex operations and measurements of multiple devices, either locally or at a distant remote site. By allowing a single operator to monitor numerous sites, GRASP provides a powerful, convenient, and time-saving method for monitoring RF equipment at distant locations.

Software licensing for this package is "break the seal".

## ORDERING INFORMATION

**S26RF00** 490P General RF Applications Software Package (GRASP) **$875**

**Includes:** Software on appropriate media (see option detail below), license agreement, and user's manual.

**OPTIONS**

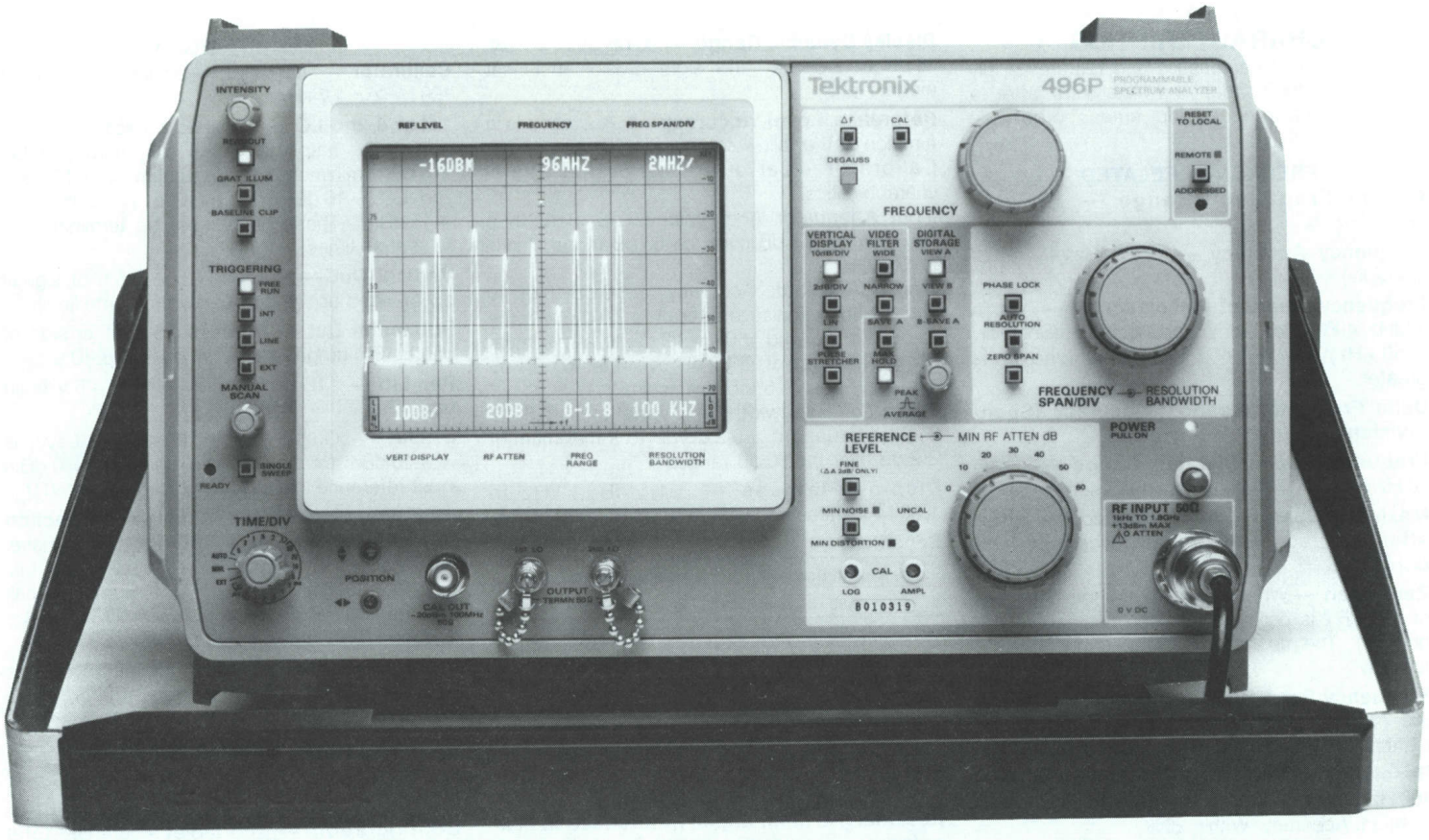
**Option 01** — IBM AT High Density Floppy Disk. **NC**

**Option 1A** — IBM PC Double Density Floppy Disk **NC**

**Option 02** — HP 9836 5 ¼ Inch Double Density Floppy Disk. **NC**

**Option 2A** — HP 9836 3 ½ Inch Micro Floppy Disk. **NC**

**Option 03** — TEK 4041 DC 100 Tape. **NC**




# 496P/496

GPIB IEEE-488 The 496P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**50 Ω/75 Ω Selectable Inputs**

**1 kHz to 1800 MHz Coverage**

**Amplitude Comparison in 0.25 dB Steps**

**1 kHz Frequency Resolution in ΔF Mode**

**Fully Calibrated Amplitude in dBm or dBmV**

**80 dB Dynamic Range**

**GPIB/Fully Programmable (496P)**

The 496 provides high performance spectrum analysis and measurements in the 1 kHz to 1.8 GHz range. Its high stability and 80 dB dynamic range meet your demands for proof-of-performance measurements, on site or on the bench.

The 496 offers state-of-the-art performance and rugged portability. Resolution bandwidth can be varied from 1 MHz to 30 Hz over the entire frequency range. Automatic phase lock stabilization reduces incidental FM to 10 Hz p-p; phase noise sidebands are at least −75 dBc at 30 times the resolution bandwidth offset. Frequency drift with phase lock is typically 1 kHz in ten minutes after 30 minute warmup. And the 496 provides 1 kHz frequency resolution in ΔF mode.

### Easy to Use—Anywhere

Simple 1, 2, 3 knob adjustment sets center frequency, frequency span and reference level. Power on sequence automatically normalizes operational settings and provides maximum input protection.

Digital storage eliminates time-consuming display adjustments. Save A, B Minus Save A, Max Hold and Average modes let you compare, subtract, save maximum values or noise average (smooth) your spectral displays. Constant tuning rate lets you position the signal quickly and accurately at any frequency span.

Microprocessor-aided controls take care of the rest. Most-used functions are automatically controlled.

### The 496 Goes Where You Go

Lightweight and compact size combine to provide unmatched portability in a laboratory quality spectrum analyzer. With its single-handle carry, the 496 is easily moved around the design lab or systems test area, to the field, or wherever it may be needed. It even fits under an airplane seat.

### 75 Ω Measurement Capability

Option 07 offers two inputs and calibrations to select from. The standard 50 Ω input calibrated in dBm is accessed via the Type N connector. The 75 Ω input connector is BNC and provides calibrated dBmV measurement capability when activated. This option includes a 300 kHz resolution filter to enhance VHF/UHF measurements.

### Automate Your Spectrum Analysis with the 496P and TekSPANS Software

The 496P is the fully programmable/GPIB compatible version of the 496 Spectrum Analyzer. Operation, features and benefits of the 496P are essentially the same as the 492P.

Enhance the 496P measurement capability with the *NEW* TekSPANS general RF applications software. See page 158 for a complete description.

Manual instruments can be converted to programmable instruments at a later time. Contact your Tektronix sales engineer for details.

## CHARACTERISTICS

The following characteristics and features apply to the 496/496P Spectrum Analyzers after a 30 minute warm-up period unless otherwise noted.

### FREQUENCY RELATED

**Center Frequency Range** — 1 kHz to 1800 MHz.

**Frequency Accuracy** — ±(5 MHz +20% of span/div).

**Frequency Readout Resolution*1** — Within 1 MHz. 496P Tune Command Accuracy (Span/div ≤50 kHz): ±7% or ±100 Hz, whichever is greater.

**Delta Frequency Readout Accuracy (Span/Division ≤50 kHz)*1** — ±5%.

**Frequency Span/Division Range** — From 50 Hz/div to 100 MHz/div in a 1-2-5 sequence.

**Maximum Span** — When selected, the entire effective frequency range is scanned and displayed.

**Zero Span** — When selected, the horizontal axis of the CRT is calibrated in time (instead of frequency). The span/div readout is changed to time/div.

**Frequency Span/Division Accuracy** — Within 5% of the selected span/div over the center eight division of the ten division CRT display.

**Resolution Bandwidth (−6 dB)** — 30 Hz, then 100 Hz to 1 MHz in decade steps, plus an Auto position. Accuracy: Within 20%.

**Resolution Shape Factor (60 dB/6 dB)** — 7.5:1 or less. 15:1 or less for 30 Hz resolution bandwidth.

**Residual FM (Short Term), Phase Lock On** — ≤10 Hz p-p over 20 ms.

**Residual FM (Short Term), Phase Lock Off** — ≤1 kHz p-p over 20 ms.

**Long Term Drift (at Constant Temperature and Fixed Center Frequency)** — 330 Hz/10 minutes after one hour warm-up phase locked.

**Noise Sidebands** — At least −75 dBc at 30 times the resolution bandwidth offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth or less).

**1 ΔF mode provides measurements to the nearest kHz plus direct center frequency readout to the nearest kHz between 1 kHz and 500 kHz.*

### AMPLITUDE RELATED

**Reference Level Range (Full Screen, Top of Graticule)** — −123 dBm to +40 dBm (+40 dBm includes maximum safe input of +30 dBm and 10 dB of IF gain reduction) for 10 dB/div and 2 dB/div Log modes. 20 nV/div to 2 V/div (1 W maximum safe input) in Lin mode.

**Reference Level Steps** — 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when Minimum Noise is active) unless Minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each Reference Level change below −30 dBm (−20 dBm when Minimum Noise is active).

**Display Dynamic Range** — 80 dB at 10 dB/div, 16 dB at 2 dB/div, and eight division in Linear mode.

**Reference Level Accuracy** — Accuracy is a function of the following characteristics.

Calibrator: (Cal out). See output signal characteristics.

Input Attenuator Accuracy: 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, 1 kHz to 1.8 GHz.

Display Amplitude Accuracy: ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin mode is 5% of full scale.

Resolution Bandwidth Gain Variation: ±0.5 dB.

IF Gain Variation: ±0.2 dB/dB to a maximum of ±2 dB over the 90 dB range.

**Display Flatness** — ±1.5 dB, 1 kHz to 1800 MHz measured with ≥10 dB RF attenuation.

**Sensitivity**

| Resolution Bandwidth | Average Noise Level |
|---|---|
| 30 Hz | −127dBm |
| 100 Hz | −123 dBm |
| 1 kHz | −115 dBm |
| 10 kHz | −105 dBm |
| 100 kHz | −95 dBm |
| 1 MHz | −85 dBm |

### SPURIOUS RESPONSE

**Residual (No Input Signal Referenced to Mixer Input)** — −100 dBm or less.

**Harmonic Distortion (cw Signal, Minimum Distortion Mode)** — Typically −60 dBc for a full-screen signal.

**Third-Order Intermodulation Distortion (Minimum Distortion Mode)** — At least −70 dBc below any two on-screen signals within any frequency span.

**LO Emissions (0 dB Attenuation)** — −70 dBm maximum.

**Zero Frequency Spur (Referenced to Input Mixer)** — −20 dBm or less.

### INPUT SIGNAL

**RF Input** — Type N female connector.

**Input Impedance** — 50 Ω; vswr 1.3:1 maximum (1.2:1 typical) with 10 dB or more RF attenuation. 2.0:1 (1.9:1 typical) with 0 dB attenuation.

**Input Level (Optimum Level for Linear Operation)** — −30 dBm referred to input mixer. Full screen not exceeded and Min Distortion control setting.

**1 dB Compression Point** — −18 dBm, no RF attenuation.

**Maximum Input Level (RF Attenuation at 0 dB)** — +30 dBm.

**Maximum Input Level (with 20 dB or More RF Attenuation)** — +30 dBm (1 W) continuous 75 W peak, pulse width 1 μs or less with a maximum duty factor of 0.001 (attenuation limit). Dc must never be applied to RF input.

### OUTPUT SIGNAL

**Calibrator** — (Cal Out) −20 dBm ±0.3 dB at 100 MHz ±1.7 kHz.

**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +6 dBm minimum to a maximum of +15 dBm, 2nd LO −16 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

**Vertical Out** — Provides 0.5 V ±5% of signal/div of video above and below the centerline.

**Horizontal Out** — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

**Pen Lift** — TTL compatible, nominal +5 V to lift pen.

**IF Out** — Output of the 10 MHz IF. Level is ≈−16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

**IEEE Standard 488-1978 Interface Function Subsets Implemented (496P)** — Handshake: SH1. Acceptor Handshake: AH1. Talker: T5. Listener: L3. Service Request: SR1. Remote/Local: RL1. Parallel Poll: PP1. Device Clear: DC1. Device Trigger: DT1. Controller: C0.

**Probe Power** — Provides operating voltages (+5 V, +15 V, −15 V, and ground) for active probes.

### GENERAL CHARACTERISTICS

For detailed specifications refer to the 492 on page 164.

**Configuration** — (Portable) 496/496P total weight including front cover and standard accessories 20 kg (44 lb), 17.5 cm x 32.7 cm x 49.9 cm (6.9 in x 12.9 in x 19.7 in) without handle or cover.

### ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C Type III, Class 3, Style C.

**Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 12 000 m (40,000 ft).

**Vibration** — 5 Hz to 55 Hz at 0.020 inch excursion.

**Humidity** — Operating: 95%. Nonoperating: 120 hours per MIL-STD-810.

**Shock** — 30 g of half sine 11 ms duration.

**Rain Resistance** — Drip proof at 16 liters/hour/square foot.

**Drop** — 12 inches.

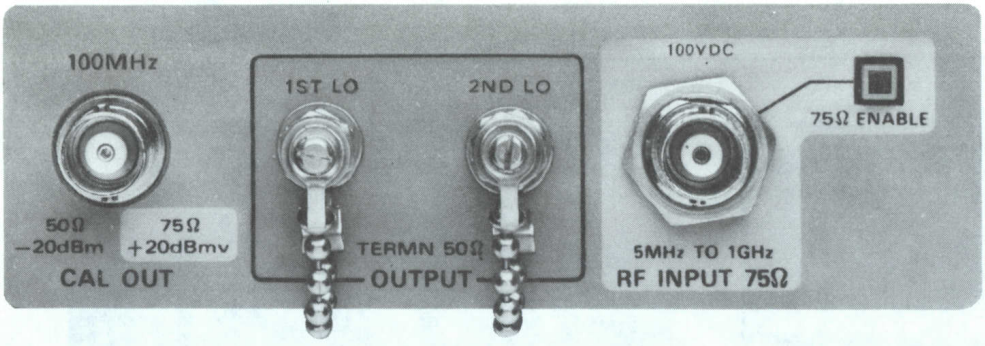
**Electromagnetic Compatibility** — 490 Series spectrum analyzers meet the requirements of MIL-STD-461B, operating from 48 Hz to 440 Hz power sources, with the exceptions shown below.

Conducted Emissions: CE01: 1 kHz to 15 kHz only. CE03 (Narrowband): Full limits. CE03 (Broadband): 15 dB relaxation from 15 kHz to 50 kHz.

Conducted Susceptibility: CS01: Full limits. CS02: Full limits. CS06: Full limits.

Radiated Emissions: RE01: 10 dB relaxation for first ten harmonics of power line frequency, and exceptioned from 30 kHz to 36 kHz. RE02: Full limits.

Radiated Susceptibility: RS01: Full limits. RS02-1: Full limits. RS02-2: To 5 A only. RS03: Up to 1 GHz only.




*Option 07 75 Ω Input.*

### OPTION 07 CHARACTERISTICS
### 50 Ω INPUT RELATED

Characteristics are the same as the base instruments except for the following:

**300 kHz Resolution Filter** — Replaces the 100 kHz filter.

**Sensitivity** — Average noise level at 300 kHz bw is −90 dBm.

### 75 Ω INPUT RELATED

**Center Frequency Range** — 1 MHz to 1000 MHz.

**Frequency Response** — 5 MHz to 1000 MHz ±2.0 dB. 1 MHz response typically ≤−3 dB from 5 MHz response.

**Reference Level Range** — +88 dBmV to −75 dBmV.

**RF Input** — Type BNC female connector.

**Input Impedance** — 75 Ω; vswr 1.35:1 maximum; 5 MHz to 800 MHz; vswr 1.6:1 maximum, 800 MHz to 1000 MHz (with 10 dB or more of RF attenuation).

**Maximum Input Level (0 dB Attenuation)** — +78 dBmV.

**Input Coupling** — 100 Vdc maximum (dc + ac peak).

**Calibrator (Cal Out)** — +20 dBmV ±0.5 dB, 75 Ω at 100 MHz ±1.7 kHz.

## ORDERING INFORMATION

**496** Spectrum Analyzer **$24,300**

**Includes:** 18 in BNC to BNC connectors 50 Ω coax cable (012-0076-00); 6 ft N to N connectors 50 Ω coax cable (012-0114-00); 115 V power cord (161-0118-00); N male to BNC female adaptor (103-0045-00); two 4 A fast blow fuse (159-0017-00); 2 A fast blow fuse (159-0021-00); cord clamp (343-0170-00); CRT visor (016-0653-00); blue CRT light filter (378-0115-00); amber CRT light filter (378-0115-01); gray CRT light filter (378-0115-02); CRT mesh filter (378-0726-01); operator manual (070-3480-00); operator handbook (070-3483-00); service manual Volume 1 (070-3481-00); service manual Volume 2 (070-3482-00).

**496P** Fully Programmable/GPIB Spectrum Analyzer **$28,950**

**Includes:** In addition to the above a 2 meter double shield GPIB cable (012-0630-03); programmers manual (070-3484-00).

### OPTIONS (496/496P)

**Option 07** — 75 Ω/50 Ω Input. **+$750**

**Option 30** — Rackmount. 19 inch rack width with front panel input/outputs. **+$790**

**Option 31** — Rackmount. 19 inch rack width with rear panel input/output capability. **+$840**

**Option 32** — Benchmount. Adds side and top panels, carrying handles and feet for a stackable benchtop configuration. **+$940**

**Option 42** — 110 MHz IF Output. Provides 5 MHz bandwidth at 6 dB points. **$1,500**

### CONVERSION KIT

**496 to 496P** — Conversions are made by your nearest Tektronix service center. Order 040-1046-04 **$5,500**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 , 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

## OPTIONAL ACCESSORIES

**TR 503 Tracking Generator** — (For more information see page 172. **$6,620**

**75 Ω to 50 Ω Power Splitter** — Order 067-1232-00 **$250**

**75 Ω to 50 Ω Minimum Loss Attenuator** — Order 011-0112-00 **$60**

**Dc Block N to N** — Order 015-0509-00 **$250**

**P6201 FET Probe to 900 MHz** — Order 010-6201-01 **$1,220**

**1405 TV Sideband Adaptor** — 525/60 Markers. (See page 173.) **$5,780**

**TV Trigger Synchronizer** — Order 015-0261-01 **$450**

**Hard Case (Transit)** — Order 016-0658-00 **$725**

**Soft Case** — Order 016-0659-00 **$100**

**Rear Panel Protective Cover** — Order 337-3274-00 **$5**

**Lab Cart** — K213. (See page 424.) **$595**

**Camera** — C-5C. (See page 416.) **$495**

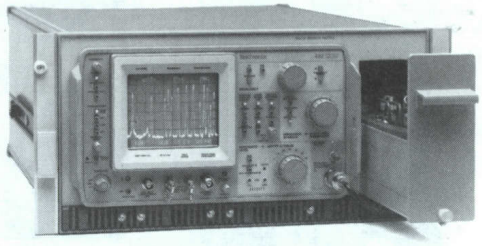
*Note: The 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 cameras.*

### PERIPHERAL PRODUCTS FOR 494P SPECTRUM ANALYZER

**4041** System Controller. (See page 298.) **$3,995**

**4105A** Color Terminal. (See page 58.) **$3,995**

**4695** Color Graphics Copier. (See page 77.) **$1,595**

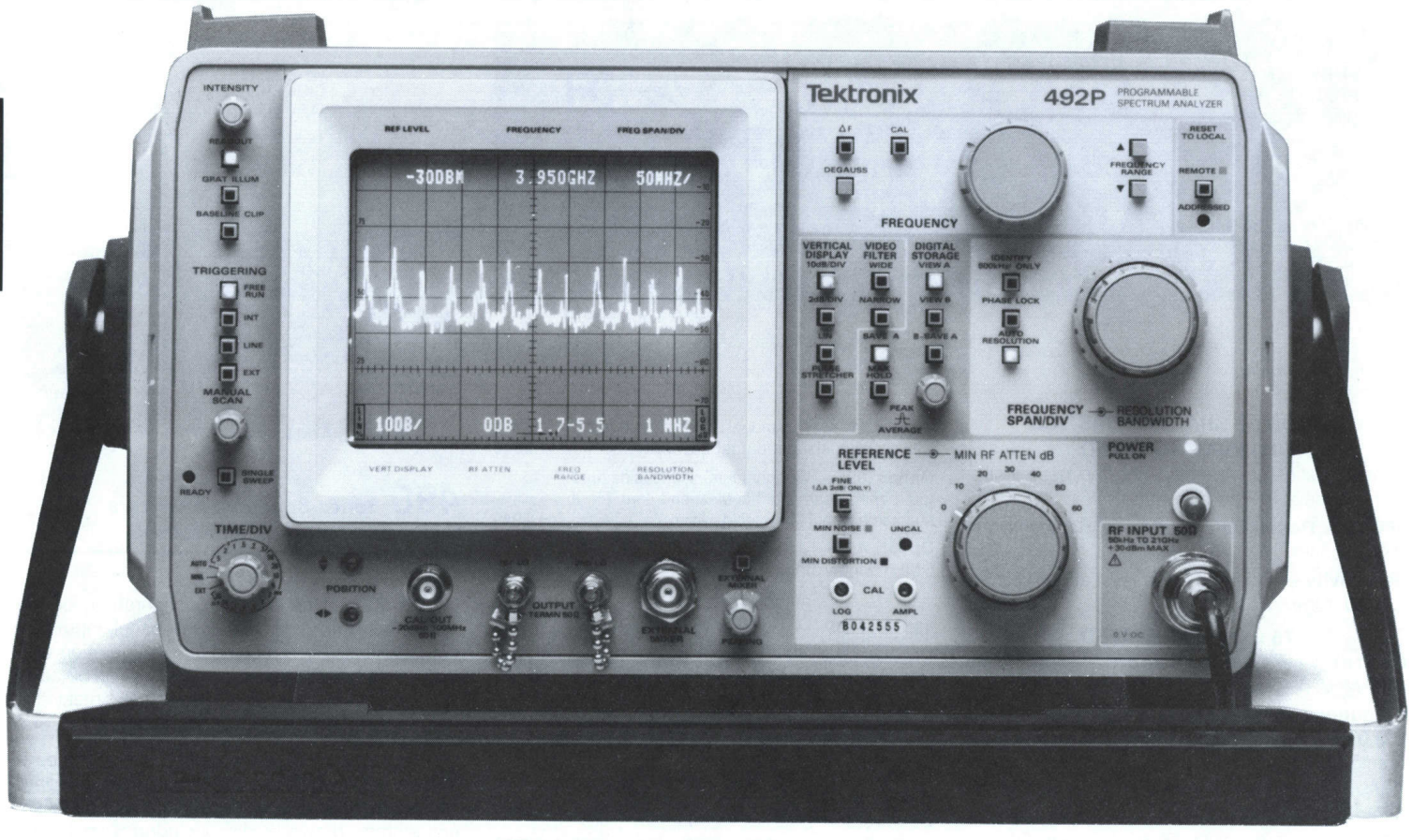


## 490 Series Spectrum Analyzers
### Rackmount/Benchmount Options

Option 30 is a rackmount configuration for the 490 Series with standard front panel input/outputs. Option 31 is a rackmount configuration with rear panel input/output capability. Option 32 adds side covers and trim to an Option 31, making it into a stackable bench top configuration.

Options 30 and 31 Rackmount are a standard 19 inch rack width and come with standard rackmount fittings. A spectrum analyzer accessories storage drawer is also included. Dimensions are 22.23 cm x 42.9 cm x 63.5 cm (8.75 in x 16.89 in x 25.0 in). Weight is 32.7 kg (72 lb); including the spectrum analyzer.

The Option 32 Benchmount is approximately the same size as the Rackmount but is dressed with side and top panels and carrying handles and feet. The Benchmount provides a convenient surface for stacking other instruments. Dimensions are 23.5 cm x 45.7 cm x 63.5 cm (9.25 in x 17.9 in x 25.0 in). Weight is 31.8 kg (70 lb); including the spectrum analyzer.




# 492P/492

GPIB IEEE-488 The 492P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Portable Form Factor (Compact Size/Lightweight)**

**50 kHz to 220 GHz Frequency Range**

**Amplitude Comparison in 0.25 dB Steps**

**80 dB Dynamic Range**

**Wide Range of Options**

**GPIB/Fully Programmable (492P)**

**Freedom from Spurious Responses Through Preselection**



### Lab Quality You Can Get a Handle On

The 492 is a high performance, rugged, instrument of compact size, with microprocessor logic control. Full programmability via GPIB (IEEE Standard 488-1978) compatibility is available in the 492P version.

Three-knob operation provides use as simple as 1, 2, 3 through microprocessor coupled functions such as resolution bandwidth, video bandwidth, sweep time, frequency span, RF attenuation, and reference level. Measurement accuracy is enhanced through the use of Δ dB mode, which switches in 0.25 dB steps.

Digital storage and processing facilitate trace comparisons and add measurement capability through the Max Hold function for frequency drift and amplitude change measurements. Arithmetic operations can be performed between traces or between a trace and a reference. Digital noise averaging mode results in trace smoothing. With digital storage, the display is steady and without flicker, even at the lowest sweep speeds; plus trace values may be retained as long as power is on.

### 492P Makes Spectrum Analysis Automatic, and Easy.

Two instruments in one, the 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. Push the "Reset to Local" button and the 492P becomes a 492—with operation from the front panel. But, most important, the 492P opens the way to automated spectrum analysis and documentation via its IEEE Standard 488 (GPIB) interface. This versatility makes the 492P useful in many applications in the lab, factory or field.

### ATE Software Enhances Utility

The *NEW* TekSPANS software expands the 492P into a fully automated measurement package for general RF applications. Increase productivity and measurement repeatability of the 492P with a Tek 4041 Controller—or if you prefer your own IBM PC or HP controller. See page 158 for details.

### Add Programmability

Programmability/GPIB features can be added to 492 Spectrum Analyzers. This means if you want to delay a programmability/GPIB decision because of budget constraints, or for any other reason, you can convert your 490 Series spectrum analyzer later. Conversions are made at designated Tektronix Service Centers.

### Easy to Use

The 492P is designed for ease of operation via the GPIB, just as the 492 is designed for front panel operational ease. Most commands for program control are simply abbreviations of the front panel nomenclature.

The 492P's high level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

**Put it to Work**

With the programmable 492P on your measurement team, repetitive measurements can be done the same way every time. Your throughput will increase—as will your confidence in results. And, the internal processing and high level programming language makes software development faster. You get high power results with easy programming. When you look at the total performance capability of the 492P, you'll recognize its value: ease of operation both as a programmable and manual instrument. Wide frequency range. The versatility to go where you go. Into the lab for automated testing; into the field for data collection.

For more information on the application and benefits of the 490 Series spectrum analyzers under program control, ask for brochure 26W-5177.

## CHARACTERISTICS

The following characteristics and features apply to the 492/492P Spectrum Analyzers after a 30 minute warmup period unless otherwise noted.

### FREQUENCY RELATED

**Center Frequency Range —** 50 kHz to 21 GHz standard, amplitude specified coverage to 220 GHz with optional Tektronix waveguide mixers.

**Frequency Accuracy —** ±(5 MHz +20% of span/div) or ±(0.2% of the center frequency +20% of span/div) whichever is greater after two hour warmup.

**Readout Resolution —** Within 1 MHz.

**Frequency Span/Division Range —** 10 kHz to 500 MHz/div in a 1-2-5 sequence in the 50 kHz to 21 GHz center frequency range. Option 03 provides additional span ranges of 500 Hz, 1 kHz, 2 kHz, and 5 kHz/div.

**Frequency Span/Division Accuracy —** ±5% of span/div, measured over center eight divisions.

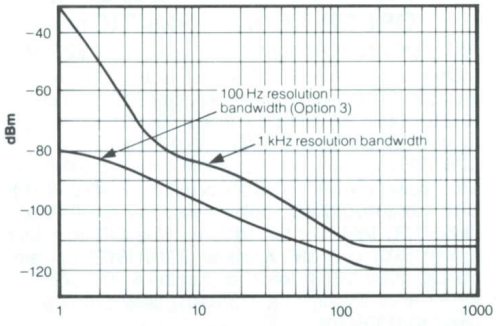
**Resolution Bandwidth (−6 dB Points) —** 1 MHz to 1 kHz (100 Hz for Option 03) in decade steps, plus an Auto position. Resolution is within 20% of selected bandwidth.

**Resolution Shape Factor (60 dB/6 dB) —** 7.5:1 or less.

**Residual FM —** 1 kHz p-p for 2 ms time duration, improves to (50 Hz) for 20 ms with phaselock Option 03.

**Long Term Drift (At Constant Temperature and Fixed Center Frequency) —** 3 kHz/10 minutes after one hour warmup with Option 03 for fundamental mixing.

**Noise Sidebands —** At least −75 dBc at 30X resolution offset from the center frequency (−70 dBc for 100 Hz resolution bandwidth Option 03).




*Typical low end frequency performance for the 492 with Option 03.*

### AMPLITUDE RELATED

**Reference Level Range —** Full screen, top of graticule −123 dBm to +40 dBm (+40 dBm, includes maximum safe input of +30 dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.

**Reference Level Steps —** 10 dB, 1 dB, and 0.25 dB for relative level (Δ) measurements in Log mode. 1-2-5 sequence and 1 dB equivalent increments in Lin mode. The RF attenuator steps 10 dB for reference level changes above −30 dBm (−20 dBm when minimum noise is active) unless minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each reference level change below −30 dBm (−20 dBm when minimum noise is active).

**Display Dynamic Range —** 80 dB at 10 dB/div, 16 dB at 2 dB/div and eight division in linear mode.

**Reference Level Accuracy —** Accuracy is a function of the following characteristics listed below.

Calibrator: (Cal out) See output signal characteristics.

Input Attenuator Accuracy: 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range, up to 4 GHz; 0.5 dB/10 dB to a maximum of 1.4 dB over the 60 dB range from 4 GHz to 21 GHz.

Frequency Response: See frequency response table above.

Display Amplitude Accuracy: ±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. Lin Mode is 5% of full scale.

Resolution Bandwidth Gain Variation: ±0.5 dB.

IF Gain Variation: ±0.2 dB/dB to a maximum of ±2 dB over the 90 dB range.

### SPURIOUS RESPONSES

**Residual (No Input Signal Referenced to Mixer Input) —** −100 dBm or less.

**Harmonic Distortion (cw Signal, Minimum Distortion Mode) —** Typically −60 dBc for full screen signal in the minimum distortion mode to 21 GHz. At least −100 dBc for preselected Option 01. 1.7 GHz to 21 GHz.

**Third-Order Intermodulation Distortion (Minimum Distortion Mode) —** At least 70 dB down from two full screen signals within any frequency span. At least 100 dB down for two signals spaced more than 100 MHz apart from 1.7 GHz to 21 GHz for preselected Option 01.

**LO Emissions (0 dB Attenuation) —** −10 dBm maximum; −70 dBm maximum to 21 GHz for Option 01.

### INPUT SIGNAL

**RF Input —** Type N female connector.

**Input Impedance —** 50 Ω.

**Maximum VSWR*[1] with ⩾10 dB Attenuation**

| Frequency Range | Typical | Specified Maximum |
|---|---|---|
| Dc to 2.5 GHz | 1.2:1 | 1.3:1 |
| 2.5 GHz to 6.0 GHz | 1.5:1 | 1.7:1 |
| 6.0 GHz to 18 GHz | 1.9:1 | 2.3:1 |
| 18 GHz to 21 GHz | 2.7:1 | 3.5:1 |

*[1] At Type N female connector to internal mixer*

### SENSITIVITY AND FREQUENCY RESPONSE

| Frequency Range | Mixing Number (n) | Average Noise Level for 1 kHz Resolution: No Preselection | Average Noise Level for 1 kHz Resolution: Preselected Option 01 | Frequency Response With 10 dB Attenuation: No Preselection | Frequency Response With 10 dB Attenuation: Preselected Option 01 |
|---|---|---|---|---|---|
| 50 kHz to 1.8 GHz* | 1 | −115 dBm | −110 dBm | | ±1.5 dB |
| 50 kHz to 4.2 GHz* | 1 | −115 dBm | −110 dBm | ±1.5 dB | |
| 1.7 GHz to 5.5 GHz | 1 | −115 dBm | −110 dBm | ±1.5 dB | ±2.5 dB |
| 3.0 GHz to 7.1 GHz | 1 | −115 dBm | −110 dBm | ±1.5 dB | ±2.5 dB |
| 5.4 GHz to 18 GHz | 3 | −100 dBm | −95 dBm (12 GHz)<br>−90 dBm (18 GHz) | ±2.5 dB | ±3.5 dB |
| 15 GHz to 21 GHz | 3 | −95 dBm | −85 dBm | ±3.5 dB | ±5.0 dB |
| 100 MHz to 18 GHz*** | | | | ±3.5 dB | ±4.5 dB |
| **WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WM 490 SERIES WAVEGUIDE MIXERS (See Page 165)** | | | | | |
| 18 GHz to 26 GHz | 6 | −100 dBm | | ±2.0 dB | |
| 26 GHz to 40 GHz | 10 | −95 dBm | | ±2.0 dB | |
| 33 GHz to 50 GHz | 10 | −95 dBm | | ±2.0 dB | |
| 40 GHz to 60 GHz | 10 | −95 dBm | | ±2.5 dB | |
| 60 GHz to 90 GHz | 15 | −95 dBm @ 60 GHz† | | ±3.0 dB**† | |
| | | −85 dBm @ 90 GHz† | | ±3.0 dB**† | |
| 90 GHz to 140 GHz | 23 | −85 dBm @ 90 GHz† | | ±3.0 dB**† | |
| | | −75 dBm @ 140 GHz† | | ±3.0 dB**† | |
| 140 GHz to 220 GHz | 37 | −65 dBm @ 220 GHz† | | ±3.0 dB**† | |

** Low frequency end performance does not include effects due to 0 Hz feedthrough.*

*** Over any 5 GHz bandwidth.*

**** Includes frequency band switching error of 1 dB maximum.*

*† Typical*

**Input Level (Optimum Level for Linear Operation)** — −30 dBm referenced to input mixer. Full screen not exceeded and minimum distortion control settings.

**1 dB Compression Point** — −18 dBm.

**Maximum Safe Input Level (RF Attenuation at Zero dB)** — +13 dBm without Option 01. +30 dBm (1 W) with Option 01.

**Maximum Input Level (with 20 dB or more RF Attenuation)** — +30 dBm (1 W) continuous, 75 W peak for 1 μs or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

### OUTPUT SIGNAL

**Calibrator** — (Cal Out) −20 dBm ±0.3 dB, 100 MHz ±1.7 kHz.

**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm; 2nd LO −22 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

**Vertical Out** — Provides 0.5 V ±5% of signal/div of video above and below the center line.

**Horizontal Out** — Provides 0.5 V either side of center. Full range −2.5 V to +2.5 V ±10%.

**Pen Lift** — TTL, +5 V nominal to lift pen.

**IF Out** — Output of the 10 MHz IF. Level is approximately −16 dBm for a full screen signal at −30 dBm input reference level. Nominal impedance 50 Ω.

**IEEE Standard 488-1978 Interface Function Subsets Implemented (494P)** — Source Handshake: SH1. Acceptor Handshake: AH1. Talker: T5. Listener: L3. Service Request: SR1. Remote/Local: RL1. Parallel Poll: PP1. Device Clear: DC1. Device Trigger: DT1. Controller: C0.

### GENERAL CHARACTERISTICS

**Sweep Time** — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

**CRT Readout** — Displays reference level, center frequency, frequency range, vertical display mode, frequency span/div resolution bandwidth and RF attenuation.

**CRT** — 8 cm x 10 cm, GH (P31) phosphor standard.

**Input Voltage** — 90 V ac to 132 V ac or 180 V ac to 250 V ac, 48 Hz to 440 Hz.

**Power** — 210 W maximum with all options, at 115 V and 60 Hz.

**Configuration** — (Portable) 492/492P: total wight including front cover and standard accessories 20 kg (44 lb) 17.5 cm x 32.7 cm x 49.9 cm (6.9 in x 12.9 in x 9.7 in) without handle or cover.

### ENVIRONMENTAL CHARACTERISTICS

Per MIL-T-28800C Type III, Class 3, Style C. See page 160.



## ORDERING INFORMATION

**492** Spectrum Analyzer **$23,500**

**Includes:** 18 inch BNC to BNC connector 50 Ω coax cable (012-0076-00); 6 ft N to N connector 50 Ω coax cable, (012-0114-00); 2 A fast blow fuse (159-0021-00); N male to BNC female adaptor (103-0045-00); CRT mesh filter (378-0726-01); two 4 A fast blow fuse (159-0017-00); 115 V power cord (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); diplexer assembly (015-0385-00); amber CRT light filter (378-0115-01); blue CRT light filter (378-0115-00); gray CRT light filter (378-0115-02); operator manual (070-2726-03); operator handbook (070-2729-01); service manual volume 1 (070-3783-01); service manual volume 2 (070-3784-01).

**492P** Fully Programmable/GPIB/Digital Storage Spectrum Analyzer **$31,750**

**Includes:** In addition to the above a 2 m, double shield GPIB cable (012-0630-03); programmer manual (070-3401-00).

### OPTIONS (492/492P)

**Option 01** — Calibrated Internal Preselection. Filtering of input to first mixer for each frequency band. **+$3,995**

**Option 02** — (492 Only) Digital Storage. With Save A, maximum hold, B minus Save A, display averaging, and storage bypass. **+$1,950**

**Option 03** — Frequency Stabilization/100 Hz Resolution. Provides first local oscillator stabilization by phase locking the oscillator to an internal reference. **+$3,590**

**Option 08** — Delete External Mixer Capability. Deletes internal switching front panel connector and external diplexer to connect and use external wavequide mixers. **−$1,750**

**Option 11** — (492P Only) Automatic Preselector Peaking. To store peak preselector values in bands 2, 3, and 4. **+$450**

**Option 20** — General Purpose 12.4 GHz to 40 GHz Waveguide Mixer Set. (12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz, and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency. **+$900**

**Option 21** — High Performance 18 GHz to 40 GHz Waveguide Mixer Set. (18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz) and attaching hardware to extend the upper frequency. **+$2,525**

**Option 22** — High Performance 18 GHz to 60 GHz Waveguide Mixer Set. (18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, and 40 GHz to 60 GHz) and attaching hardware to extend the upper frequency. **+$4,250**

**Option 30** — Rackmount. 19 inch rack width with front panel input/outputs. **+$790**

**Option 31** — Rackmount. 19 inch rack width with rear panel input/output capability. **+$840**

**Option 32** — Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration. **+$940**

**Option 41** — Digital Radio. Provides wider bandwidth preselector, 30 Hz video filter with 100 kHz resolution bandwidth and 5 MHz span/div optimized for 6 GHz and 11 GHz D/R. **$450**

**Option 42** — 110 MHz IF Output. Provides 5 MHz bandwidth at 6 dB points. **$1,500**

### CONVERSION KIT

**492 to 492P Conversion** — Conversion made by your Tektronix service center. For 492's with Options 01, 02, 03, 08. Order 040-1038-02 **$7,560**

For 492's with Options 01, 02, 03. Order 040-1037-03 **$7,560**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

## OPTIONAL ACCESSORIES

**TR 503 Tracking Generator** — (See page 172.) **$6,620**

**Microwave Comb Generator TM 500 Series Compatible** — Order 067-0885-00 **$1,800**

**75 Ω to 50 Ω Minimum Loss Attenuator** — Order 011-0112-00 **$60**

**Dc Block N to N** — Order 015-0509-00 **$85**

**P6201 FET Probe to 900 MHz** — Order 010-6201-01 **$1,220**

**1405 TV Sideband Adaptor** — 525/60 Markers. (See page 173.) **$5,780**

**TV Trigger Synchronizer** — Order 015-0261-01 **$450**

**Hard Case (Transit)** — Order 016-0658-00 **$725**

**Soft Case** — Order 016-0659-00 **$100**

**Rear Panel Protective Cover** — Order 337-3274-00 **$5**

**Lab Cart** — K213. (See page 424.) **$595**

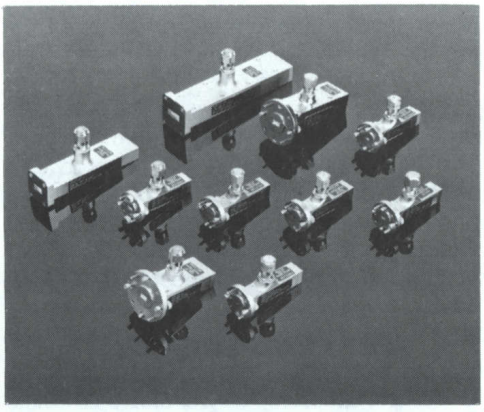
**Camera** — C-5C. (See page 416.) **$495**

*Note: The 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 cameras.*

### PERIPHERAL PRODUCTS FOR 492P SPECTRUM ANALYZER

**4041** System Controller. (See page 298.) **$3,995**
**4105A** Color Terminal. (See page 58.) **$3,495**
**4695** Color Graphics Copier. (See page 76.) **$1,595**

See page 158 for complete description of the Tek's GRASP (General RF Applications Software Package).



# 490 Series Waveguide Mixers

The 490 Series Tektronix Waveguide Mixers cover from 18 GHz to 325 GHz with optimum sensitivity. They are designed specifically for use with the Tektronix 490 Series Spectrum Analyzers.

The two microwave mixers cover ranges 18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz. They have field replaceable diodes and frequency response of ±2 dB when used with the spectrum analyzers indicated above.

Eight millimeter wave mixers cover the 33 GHz to 220 GHz range in the standard Milspec band ranges. J to G band flange transition (119-1728-00) converts the WM 490G mixer to cover the 220 GHz to 325 GHz range.

The mixers are all gold plated brass, conforming to MIL-G-45204 Class I, Type 1 specifications and will withstand harsh environments. Mixer sets come complete with a container for spare diodes, a 28-inch cable, an instruction manual and a wood storage box with foam cutout storage locations for five mixers.

## CHARACTERISTICS

**For All Waveguide Mixers —** Maximum cw RF Input Level: +20 dBm (100 mW).

**Maximum PULSED RF Input Level —** 1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width.

**LO Requirement —** +7 dBm minimum, +15 dBm maximum, +10 dBm typical.

**Bias Requirement —** −2.0 V to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0 mV to 20 mA of bias current.

**1 dB Compression Point —** +13 dBm typical.

**Amplitude Accuracy —** ±6 dB maximum reference level error with respect to the internal calibrator.

## INDIVIDUAL MIXER ELECTRICAL CHARACTERISTICS

| Frequency Range (GHz) | Tektronix Model No | Band Designation | Sensitivity (dBm)*1 | Frequency Response*2 | Conversion Loss*3 Typical |
|---|---|---|---|---|---|
| 18 to 26.5 | WM 490K | K | −100 | ±2 dB | −30 dB |
| 26.5 to 40 | WM 490A | A | −95 | ±2 dB | −30 dB |
| 33 to 50 | WM 490Q | Q | −95 | ±2 dB | −30 dB |
| 40 to 60 | WM 490U | U | −95 | ±2.5 dB | −30 dB |
| 50 to 75 | WM 490V | V | −95 at 50 GHz<br>−90 at 75 GHz<br>typical | ±3 dB<br>typical*4 | −30 dB at 50 GHz<br>−35 dB at 75 GHz |
| 60 to 90 | WM 490E | E | −95 at 60 GHz<br>−85 at 90 GHz<br>typical | ±3 dB<br>typical*4 | −30 dB at 60 GHz<br>−40 dB at 90 GHz |
| 75 to 110 | WM 490W | W | −90 at 75 GHz<br>−80 at 110 GHz<br>typical | ±3 dB<br>typical*4 | −35 dB at 75 GHz<br>−45 dB at 110 GHz |
| 90 to 140 | WM 490F | F | −85 at 90 GHz<br>−75 at 140 GHz<br>typical | ±3 dB<br>typical*4 | −40 dB at 90 GHz<br>−50 dB at 140 GHz |
| 110 to 170 | WM 490D | D | −80 at 110 GHz<br>−70 at 170 GHz<br>typical | ±3 dB<br>typical*4 | −45 dB at 110 GHz<br>−55 dB at 170 GHz |
| 140 to 220 | WM 490G | G | −75 at 140 GHz<br>−65 at 220 GHz<br>typical | ±3 dB<br>typical*4 | −50 dB at 140 GHz<br>−60 dB at 220 GHz |
| 220 to 325 | 119-1728-00*6 | J | −65 at 220 GHz<br>−50 at 325 GHz<br>typical*5 | ±3 dB<br>typical*4 | −60 dB at 220 GHz<br>−70 dB at 325 GHz |

*1 *Equivalent average noise level at 1 kHz bandwidth.*

*2 *Maximum amplitude variation across each waveguide mixer band (with peaking control optimized at each frequency in response to a −30 dBm CW input signal to the mixer).*

*3 *490 LO drive +10 dBm peaking control optimized.*

*4 *Over any 5 GHz bandwidth for millimeter wave mixers above 60 GHz.*

*5 *Value estimated at 325 GHz.*

*6 *Tapered waveguide transition allowing WM 490G to cover this range.*

## INDIVIDUAL MIXER MECHANICAL CHARACTERISTICS

| Frequency Range (GHz) | Tektronix Model*3 | Waveguide (EIA) | Flange (JAN) | Length | Width*1 | Height*1 | Weight |
|---|---|---|---|---|---|---|---|
| 18 to 26.5 | WM 490K | WR-42 | UG-595/U | 8.97 cm (3.53 in) | 2.22 cm (.875 in) | 3.68 cm (1.45 in) | 180 g (6.5 oz) |
| 26.5 to 40 | WM 490A | WR-28 | UG-599/U | 6.93 cm (2.73 in) | 1.90 cm (0.750 in) | 3.35 cm (1.32 in) | 100 g (3.7 oz) |
| 33 to 50 | WM 490Q | WR-22 | UG-383/U | 5.37 cm (2.125 in) | 1.84 cm (0.725 in) | 2.82 cm (1.110 in) | 90 g (3.3 oz) |
| 40 to 60 | WM 490U | WR-19 | UG-383/U-M | 4.52 cm (1.78 in) | 1.84 cm*1 (0.725 in) | 2.45 cm (0.980 in) | 80 g (2.9 oz) |
| 50 to 75 | WM 490V | WR-15 | UG-385/U | 4.31 cm (1.70 in) | 0.89 cm (0.350 in) | 2.29 cm (0.900 in) | 40 g (1.5 oz) |
| 60 to 90 | WM 490E | WR-12 | UG-387/U | 4.31 cm (1.70 in) | 0.89 cm (0.350 in) | 2.29 cm (0.900 in) | 40 g (1.5 oz) |
| 75 to 110 | WM 490W | WR-10 | UG-387/U-M | 4.31 cm (1.70 in) | 0.89 cm (0.350 in) | 2.29 cm (0.900 in) | 40 g (1.5 oz) |
| 90 to 140 | WM 490F | WR-08 | UG-387/U-M*2 | 4.31 cm (1.70 in) | 0.89 cm (0.350 in) | 2.29 cm (0.900 in) | 40 g (1.5 oz) |
| 110 to 170 | WM 490D | WR-06 | UG-387/U-M*2 | 4.31 cm (1.70 in) | 0.89 cm (0.350 in) | 2.29 cm (0.900 in) | 40 g (1.5 oz) |
| 140 to 220 | WM 490G | WR-05 | UG-387/U-M*2 | 4.31 cm (1.70 in) | 0.89 cm (0.350 in) | 2.29 cm (0.900 in) | 40 g (1.5 oz) |
| 220 to 325 | 119-1728-00 G-J Band flange transition | WR-05<br>WR-03 | 74-003<br>74-005 | — | — | — | — |

*1 *Physical dimensions exclude contribution due to the diameter of round waveguide flanges in U, V, E, W, F, D and G bands.*

*2 *All mixers are equipped with standard UG-XXX/U type flanges as indicated. Flange adaptors to standard MIL-F-3022 type flanges are provided in F, D, and G bands at no additional charge.*

*3 *All mixers include a protective flange cover, an LO/IF port protective shorting cap, and two captive flange screws for round flange mixers.*

## ORDERING INFORMATION

### PERFORMANCE SPECIFIED MIXERS AND SETS

**18 GHz to 26.5 GHz** — Order WM 490K. **$1,240**

**26.5 GHz to 40 GHz** — Order WM 490A. **$1,250**

**33 GHz to 50 GHz** — Order WM 490Q. **$1,450**

**40 GHz to 60 GHz** — Order WM 490U. **$1,720**

**50 GHz to 75 GHz** — Order WM 490V. **$1,950**

**60 GHz to 90 GHz** — Order WM 490E. **$2,120**

**75 GHz to 110 GHz** — Order WM 490W. **$2,175**

**90 GHz to 140 GHz** — Order WM 490F. **$2,330**

**110 GHz to 170 GHz** — Order WM 490D. **$3,250**

**140 GHz to 220 GHz** — Order WM 490G. **$3,325**

**220 GHz to 325 GHz** — Order 119-1728-00 **$1,200**

**18 GHz to 40 GHz Set** — Order WM 4902 **$2,550**
**Includes:** WM 490K; WM 490A.

**18 GHz to 60 GHz Set** — Order WM 4903 **$4,300**
**Includes:** WM 490K; WM 490A; WM 490U.

**18 GHz to 90 GHz Set** — Order WM 4904. **$6,420**
**Includes:** WM 490K; WM 490A; WM 490U; WM 490E.

**18 GHz to 140 GHz Set** — Order WM 4905. **$8,750**
**Includes:** WM 490K; WM 490A; WM 490U; WM 490E; WM 490F.

**Cable** — Order 012-0649-00 **$31**

**Case** — Order 016-0465-01 **$30**

**140 GHz to 220 GHz** — Tapered transition 119-1729-00 used with WM 490F waveguide mixer. **$550**

### GENERAL PURPOSE WAVEGUIDE MIXER AND SET

**12.5 GHz to 18 GHz Frequency Range** — Order 119-0097-01 **$250**

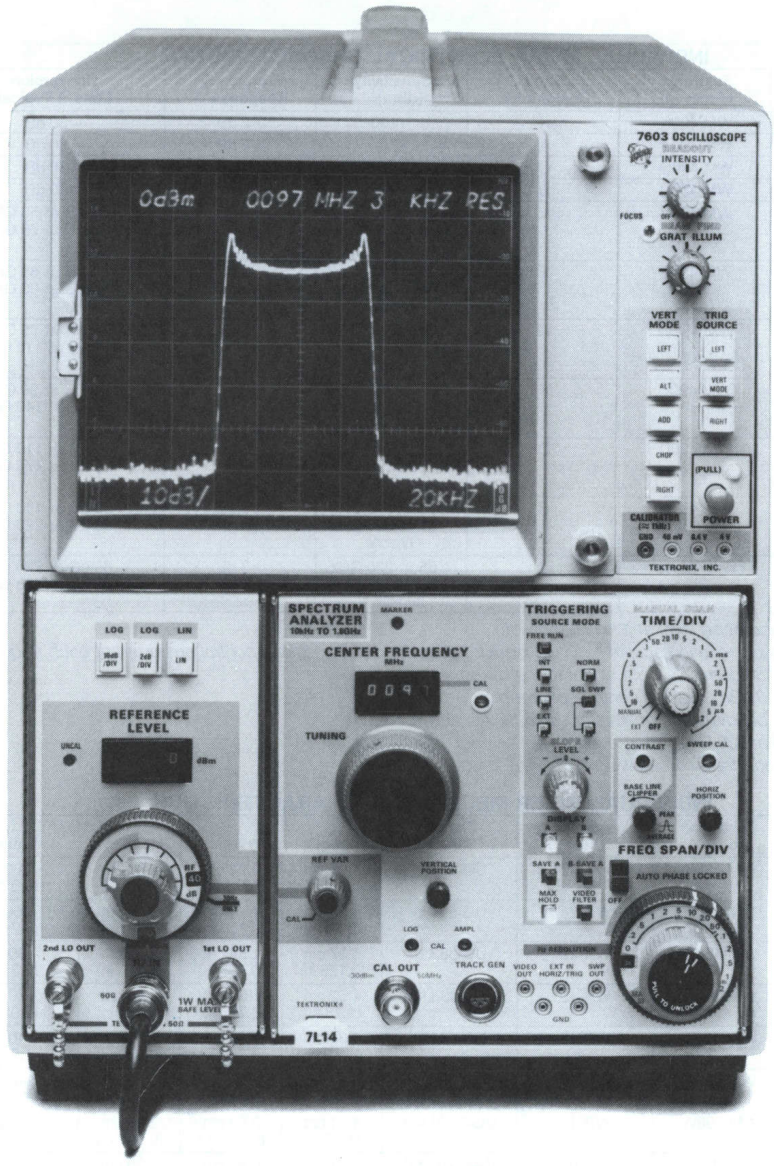
**18 GHz to 26.5 GHz Frequency Range** — Order 119-0098-01 **$275**

**26.5 GHz to 40 GHz Frequency Range** — Order 119-0099-01 **$475**

**Cable** — Order 012-0748-00 **$60**

**Case** — Order 016-0465-01 **$30**

**12.5 GHz to 40 GHz Set** — Order 016-0640-00 **$1,175**
**Includes:** 119-0097-01, 119-0098-01, 119-0099-01.




*7L14 in 7603 mainframe with internal spectrum analyzer graticule.*



# 7L14

**Excellent Stability, Resolution Bandwidth Range**

**Digital Storage and Averaging**

**Swept Measurements with the Tek TR 502**

**1 kHz to 2.5 GHz Coverage with Option 39**

**Input Limiter for Extra Input Protection**

**Semiautomatic Measurements with the Tek 7854**

The Tektronix 7L14 provides high performance spectrum analysis in the 10 kHz to 1.8 GHz range. Option 39 increases coverage to 1 kHz to 2.5 GHz. Option 23—deleting the built-in input limiter—results in 1 kHz to 1.8 GHz coverage.

7L14 capability translates to confidently making communications systems or EMC measurements. Check the 7L14's specifications to find out about its excellent resolution bandwidth range and filter shape factor, high stability, and spectral purity. Combined with the Tek TR 502 Tracking Generator, the 7L14 is the heart of a very stable scalar analysis system available at an affordable price. Check RF networks, filters, amplifiers, and more. . .see page 172 for details.

Digital storage helps you compare A and B displays; MAX HOLD captures maximum frequency excursions (as with a drifting oscillator) and max amplitudes, or short duration signals such as in spectrum occupancy monitoring. The 7L14 also features a built-in input limiter that protects the first mixer from overload—you can apply up to one watt to the 7L14.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L14 Spectrum Analyzer. The 7854 Mainframe can also be used with your choice of other Tek 7000 Series test and measurement plug-ins—versatility plus! Get full details from your Tek sales engineer or ask for Application Note Number 26W-5653.

## CHARACTERISTICS

The following characteristics and features apply to the 7L14 Spectrum Analyzer after a 20 minute warm-up period.

### FREQUENCY RELATED

**Center Frequency Range** — 10 kHz to 1.8 GHz.

**Center Frequency Readout Resolution** — Within 1 MHz.

**Center Frequency Readout Accuracy** — ±(5 MHz + 20% of frequency span/division).

**Frequency Span/Division Range** — 200 Hz/div to 100 MHz/div in calibrated steps in a 1-2-5 sequence.
Accuracy: Within 5% of the span selected.
Linearity: Within 5% of the span selected.
Maximum Span: Provides 1.8 GHz of span.
Zero Span: Provides fixed frequency operation for time domain display.

**Resolution Bandwidth (6 dB)** — 30 Hz to 3 MHz, in decade steps.
Accuracy: Within ±20% of the resolution selected.

**Resolution Shape Factor (60/6 dB)** — 4:1 or less for 3 MHz to 300 Hz; 12:1 or less for 30 Hz resolution.

**Signal Level Change Between Any Two Bandwidths** — ±0.5 dB at room temperature. ±2.0 dB maximum over operating temperature (net level at −30 dBm).

**Residual FM** — 13 Hz (p-p) when phase locked ±10 kHz (p-p) for 20 ms when not phase locked.

**Stability** — At a fixed temperature after two-hour warmup; ±2 kHz/hour phase locked; ±75 kHz/hour not phase locked. Wait ten minutes/GHz of tuning when the frequency is changed to make frequency related measurements.

### AMPLITUDE RELATED

**Display Modes**
Log 10 dB/Division: Provides 70 dB display dynamic range. Accuracy is within 0.15 dB/dB to 2 dB maximum over 70 dB dynamic range.
Log 2 dB/Division: Provides 14 dB display dynamic range. Accuracy is within ±0.4 dB/2 dB to 1.0 dB maximum over 14 dB dynamic range.
LIN: Within 10% over eight divisions. Deviation Between Display Modes (For Full Screen Signal): ±2 dB from 2 dB/div to 10 dB/div, 0.5 div from 2 dB/div to LIN.

**Reference Level**
Below 100 kHz: +30 dBm to −50 dBm, as the center frequency approaches 10 kHz.
Above 100 kHz: +30 dBm to −110 dBm in 10 dB calibrated steps.

**Display Flatness** — ±1.5 dB, with respect to 50 MHz, over any selected frequency span.

**Sensitivity** — At 50 MHz, applicable from 100 kHz to 1.8 GHz.

| Resolution Bandwidth | Averaged Noise Level |
|---|---|
| 30 Hz | −130 dBm |
| 300 Hz | −120 dBm |
| 3 kHz | −110 dBm |
| 30 kHz | −100 dBm |
| 300 kHz | −90 dBm |
| 3 MHz | −80 dBm |

### SPURIOUS RESPONSES

**Residual** — <−100 dBm (referenced to the first mixer input).

**Second Order Intermodulation Products** — 100 kHz to 1.8 GHz; down 70 dBc or more from two −40 dBm signals, within any frequency span.

**Third Order Intermodulation Products** — 100 kHz to 1.8 GHz; down 70 dBc or more from two −30 dBm signals, within any frequency span.

**RF Attenuator** — 60 dB range in 10 dB steps.

**Accuracy** — ±(0.25 dB +1.2% of dB reading).

**IF Gain**

**Range** — 70 dB (80 dB when operating in 30 Hz resolution bandwidth).

**Step Accuracy** — ±1 dB/10 dB step to ±2 dB maximum over entire range.

### GENERAL CHARACTERISTICS

**Noise Sidebands** — −70 dBc minimum at frequency offsets ≥25X resolution bandwidth settings.

**Sweep** — Triggered, manual, external.

**Sweep Time** — 10 s/div to 1 μs/div in a 1-2-5 sequence.

**Accuracy** — ±5% of selected Time/Division.

**Triggering Modes** — Internal, External, Ext in Horiz/Trig and Line.

**Sensitivity** — ±0.6 div of internal signal (p-p) and/or ±0.6 V (p-p) of external signal.

**Shipping Weight** — 10.8 kg (24 lb).

### INPUT SIGNALS

**RF Input** — Maximum Input Power Level: +30 dBm. Maximum Input Power Level to the RF Attenuator ≥10 dB: 1 W average (including dc), 100 W peak simultaneously. Input Impedance: 50 Ω; vswr 1.35 maximum with 10 dB of RF attenuation.

**External Horizontal/Trigger Input Connector** — Input Voltage Range: Typically 0 V to 10 V for 10 div sweep. Typically 0.5 V (p-p) to trigger the sweep circuits. 40 V peak maximum.

### OUTPUT SIGNALS

**Calibrator** — (Cal Out) −30 dBm, ±0.3 dB at 50 MHz, ±0.01%.

**1st Lo Out, 2nd Lo Out, Swp Out and Video Output**

### ENVIRONMENTAL

The 7L14 meets its electrical characteristics over the environmental limits per MIL-T-28800 Type III Class 6, Style E instruments. The 7L14 is operable over the limits of a MIL-T-28800 Class 5 instrument. The 7L14 is physically and electrically compatible with all Tektronix 7000 Series mainframes.

## Option 39

### Extended Frequency Range

Option 39 extends the 7L14's frequency range from 1 kHz to 2.5 GHz.

### CHARACTERISTICS

#### FREQUENCY

**Range** — 1 kHz to 2.5 GHz.

**Center Frequency Accuracy** — ±(5 MHz +0.5% of center frequency +20% of Span/Division setting).

#### AMPLITUDE

**Display Flatness** — ±1.5 for 10 kHz to 1.8 GHz, with respect to 50 MHz, +1.5, −2.5 for 1.8 GHz to 2.5 GHZ.

#### SPURIOUS RESPONSES

**Residual** — ≤−95 dBm to 2.5 MHz. ≤−100 dBm for 2.5 MHz to 1.8 GHz. ≤−60 dBm for 1.8 GHz to 2.5 GHz.

**Second Order Intermodulation Products** — Down 70 dB or more from two −40 dBm signals.

**Third Order Intermodulation Products** — Down 70 dB or more from two −30 dBm signals within any frequency span.

**IF Feed-Through** — At least 15 dB down at 2.095 GHz input.

**Images** — At least 10 dB down at 4.095 GHz to 6.795 GHz.

### ORDERING INFORMATION

**7L14** Spectrum Analyzer **$18,060**

**Includes:** Spectrum analyzer graticule, 6 ft 50 Ω coax cable with BNC connectors (012-0113-00); BNC male to female adaptor (103-0058-00); light filter (378-0625-07); amber light filter (378-0684-01); clear plastic implosion shield with Log, Lin, Ref, and F (frequency) direction markings (337-1439-01), for 7603 oscilloscope and (337-1159-02) for other 7000 Series oscilloscopes, instruction manual (070-3434-00).

**OPTIONS (7L14)**

**Option 23** — Deletes input limiter. **+$50**

**Option 39** — 1 kHz to 2.5 GHz Extended Frequency Range. **+$500**

**RECOMMENDED MAINFRAMES**

**7603** Oscilloscope, 100 MHz. (See page 201.) **$3,250**

**R7603** Rackmount Oscilloscopes, 100 MHz. (See page 201.) **$3,720**

**MAINFRAME OPTIONS (7603/R7603)**

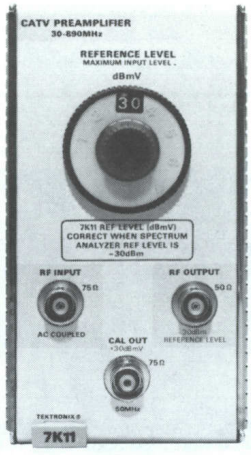
**Option 06** — Internal Spectrum Analyzer Graticule. **+$50**

**Option 08** — Protective Front Cover. (Cabinet only.) **+$115**

**Option 77** — GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

**7854** Digitizing Oscilloscope, 400 MHz. (See page 318.) **$15,830**

**Tektronix offers service training classes on the 7L14 Spectrum Analyzer. For further training information, contact your local sales/service office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.**




## 7K11 CATV Preamplifier

### 75 Ω Input Impedance and Calibration in dBmV

### Extra Sensitivity for CATV and Field Intensity Measurements

This 7000 Series plug-in preamplifier is for use with the 7L12 or 7L14 and tailored to CATV and field intensity measurement applications, where extra sensitivity is required for demanding measurements. The 7K11 handles 12 channels without overload.

The 7K11 provides a 75 Ω input impedance and calibration in dBmV. Its low noise figure makes it especially suitable for signal-to-noise and low-level radiation measurements.

### CHARACTERISTICS

**(with 7L12 or 7L14)**

**Frequency Range** — 30 MHz to 890 MHz.

**Display Flatness** — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

**Sensitivity** — Signal + noise = 2X noise, in Lin mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is ≤5 dB.

**Intermodulation Distortion** — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

**Reference Level** — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

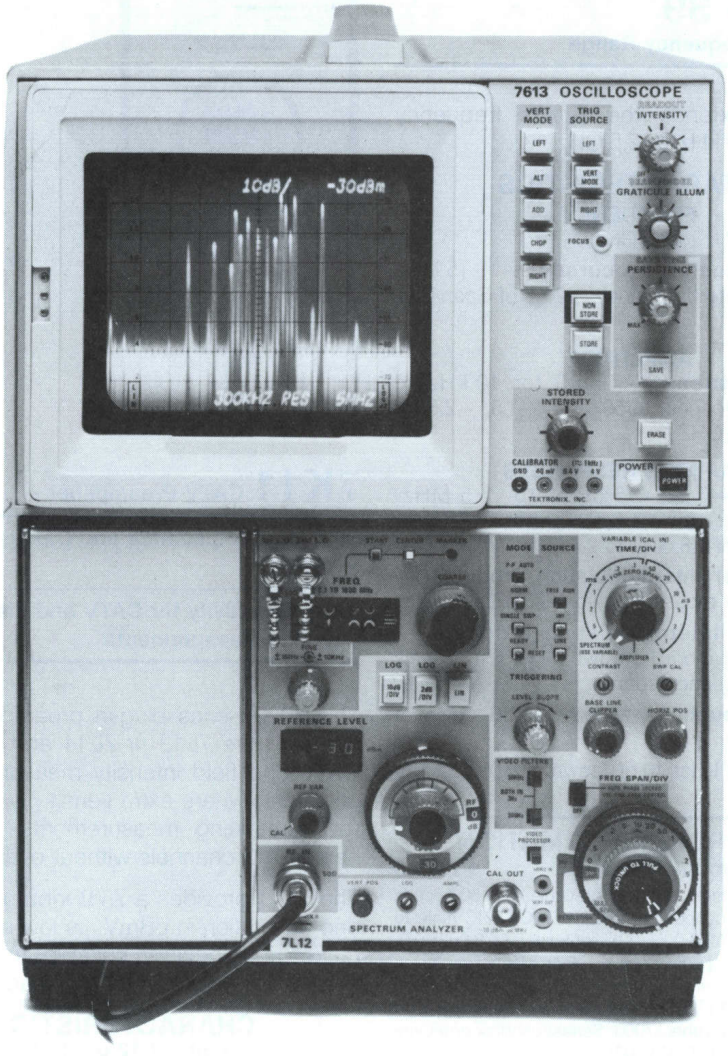
**Input Impedance** — 75 Ω.

**Calibrator** — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

### ORDERING INFORMATION

**7K11** CATV Preamplifier **$1,100**

**Includes:** 5.5 inch BNC to BNC 50 Ω cable (012-0214-00); BNC to F adaptor (013-0126-00); 42 inch BNC to BNC 75 Ω cable (012-0074-00); instruction manual (070-1664-00).




*7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence mainframe with internal spectrum analyzer graticule.*



# 7L12

**Proven, Economical VHF/UHF Coverage**

**Automatic Phase Lock
300 Hz Resolution Bandwidth**

**Swept Measurements with the TR 502**

**Coverage to 2.5 GHz (Option 39)**

**Semiautomatic Measurements with the Tek 7854**

The Tek 7L12 Spectrum Analyzer is a proven, economical performer and very popular among users across a range of applications including AM, FM and TV Broadcasting, two-way radio, and other communications systems testing. The 7L12 is also very useful in EMC and other VHF/UHF applications. By ordering Option 39, the 7L12 may be used to 2.5 GHz.

Performance you can count on includes 300 Hz resolution bandwidth/automatic phase lock stabilization, 70 dB spurious-free dynamic range and a very stable swept measurement capability (100 kHz to 1.8 GHz) using the TR 502 (see page 172). Ease-of-use features include CRT readouts of key parameters, and fully-calibrated displays.

7L12 is fully-compatible with the Tek 1405 TV Sideband Analyzer (see page 173) permitting on-the-air transmitter evaluation.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L12 Spectrum Analyzer. The 7854 can also be put to work with your choice of other Tek 7000 Series test and measurement plug-ins—versatility plus! Get full details from your Tek sales engineer or ask for Application Note Number 26W-5653.

## CHARACTERISTICS

The following characteristics and features apply to the 7L12 Spectrum Analyzer after a 40 minute warm-up period.

### FREQUENCY RELATED

**Center Frequency Range** — 100 kHz to 1.8 GHz.

**Center Frequency Readout Accuracy** — ±(8 MHz +1% of dial readout).

**Frequency Span/Division Range** — 500 Hz/div to 100 MHz/div in calibrated steps in 1-2-5 sequence.
Accuracy: Within 5% over center eight division.
Linearity: Within 5% over center eight division.
Maximum Span: Provides 1.8 GHz of span.
Zero Span: Provides fixed frequency operation for time domain display.

**Resolution Bandwidth (6 dB)** —
Range: 300 Hz to 3 MHz, in decade steps.
Accuracy: Within ±20% of the resolution selected.

**Resolution Shape Factor (60/6 dB)** — 4:1 or less.

**Signal Level Change Over the Five Bandwidths** — <0.5 dB at 20°C.

**Residual FM** — 200 Hz (p-p) when phase locked. 20 kHz (p-p) maximum in five seconds when not phase locked.

**Stability** — At a fixed temperature after two hour warm-up; within 50 kHz/hour phase locked; within 100 kHz/hour not phase locked.

### AMPLITUDE RELATED

**Display Modes** —
Log 10 dB/Division: Provides 70 dB display dynamic range. Accuracy is within 1 dB/10 dB to 1.7 dB maximum over 70 dB display dynamic range.
Log 2 dB/Division: Provides 14 dB display dynamic range. Accuracy is within ±0.4 dB/2 dB to 1.0 dB maximum over 14 dB display dynamic range.
LIN: Within 8% over eight center division. Deviation Between Display Modes: ±2 dB from 2 dB/div to 10 dB/div, 0.5 div from 2 dB/div to LIN.

**Reference Level** — +30 dBm to −100 dBm in 10 dB steps.

**Display Flatness** — ±1.7 dB over any selected frequency span, with respect to the display level at 50 MHz.

**Sensitivity for a cw Signal** — The following sensitivity characteristics apply at 50 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and to 4 dB at 1.8 GHz.

| Resolution Bandwidth | Averaged Noise Level |
|---|---|
| 300 Hz | −115 dBm |
| 3 kHz | −108 dBm |
| 30 kHz | −100 dBm |
| 300 kHz | −90 dBm |
| 3 MHz | −80 dBm |

### SPURIOUS RESPONSES

**Residual** — <−99 dBm (referenced to the first mixer input).

**Second Order Intermodulation Products** — Down 70 dB or more from two −40 dBm signals, within any frequency span.

**Third Order Intermodulation Products** — Down 70 dB or more from two −30 dBm signals, within any frequency span.

**RF Attenuator** — 60 dB range in 10 dB steps.

**Accuracy** — ±.25 dB or 1.2% of dB reading; whichever is greater.

**IF Gain**

**Range** — 70 dB.

**Step Accuracy** — ±1 dB/10 dB step to ±1.5 dB maximum over entire range.

### GENERAL CHARACTERISTICS

**Sweep Time** — 10 ms/div (Spectrum position) to 1 μs/div are provided in 1-2-5 sequence. A variable control provides continuous variation between steps. Accuracy is within 5%.

**Triggering Modes** — (P-P) Auto, Norm, Single Sweep.

**Sensitivity** — ≤0.5 div for the (p-p) Auto mode, ≤0.3 div for the Norm mode, ≤1.5 div for the Single Sweep mode.

**Shipping Weight** — 7.6 kg (17 lb).

### INPUT SIGNALS

**RF Input** — Maximum Input Power Level Linear Operation: RF Attenuator at 0 dB: −30 dBm. Input Impedance: 50 Ω.

**Safe Input Levels** — RF attenuator at 0 dB: +13 dBm. RF: Attenuator at 60 dB: +30 dBm (1 W average, 100 W peak).

**Horizontal Input** — Requires a 10 V ±1 V signal for full deflection.

### OUTPUT SIGNALS

**Cal Out** — −30 dBm, ±0.3 dB at 50 MHz, ±0.01%.

**1st LO Out, 2nd LO Out, Vert Out**

## Option 39

### Extended Frequency Range

Option 39 extends the 7L12's frequency range from 100 kHz to 2.5 GHz.

### CHARACTERISTICS

#### FREQUENCY

**Range** — 100 kHz to 2.5 GHz (Usable below 100 kHz with slightly degraded performance).

**Center Frequency Accuracy** — ±(8 MHz + 1% of dial indication).

#### AMPLITUDE

**Display Flatness** — ±1.7 dB for 100 kHz to 1.8 GHz. ±2 dB for 1.8 GHz to 2.5 GHz.

#### SPURIOUS RESPONSES

**Residual** — −95 dBm to 2.5 MHz. ≤−99 dBm for 2.5 MHz to 1.8 GHz. ≤−60 dBm for 1.8 GHz to 2.5 GHz.

**Second Order Intermodulation Products** — Down 70 dB or more from two −40 dBm signals.

**Third Order Intermodulation Products** — Down 70 dB or more from two −30 dBm signals within any frequency span.

**IF Feedthrough** — At least 15 dB down at 2.095 GHz input.

**Images** — At least 10 dB down at 4.095 GHz to 6.795 GHz.

### ORDERING INFORMATION

**7L12** Spectrum Analyzer **$10,960**

**Includes:** Spectrum analyzer graticule, clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings (337-1439-01) for 7403N and 7603 Oscilloscopes, and (337-1159-02) for other 7000 Series oscilloscopes; light filter (378-0625-07); amber light filter (378-0684-01); 6 foot 50 Ω coax cable with BNC connectors (012-0113-00); BNC Male to N Female adaptor (103-0058-00); instruction manual (070-1298-02).

**Option 39** — 100 kHz to 2.5 GHz Extended Frequency Range. **+$500**

#### RECOMMENDED MAINFRAMES

**7613** Storage Oscilloscope, 100 MHz. (See page 210.) **$5,850**

**R7613** Rackmount Storage Oscilloscope, 100 MHz. (See page 210.) **$6,315**

**7603** Oscilloscope, 100 MHz. (See page 201.) **$3,250**

**R7603** Rackmount Oscilloscope, 100 MHz. (See page 201.) **$3,720**

**7854** Digitizing Oscilloscope, 400 MHz. (See page 318.) **$15,830**

#### MAINFRAME OPTIONS (7603/R7603, 7613/R7613)

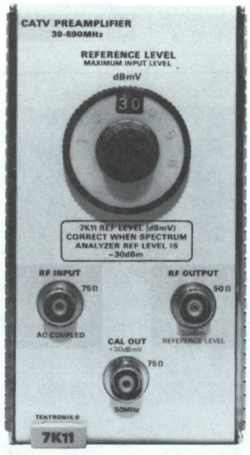
**Option 06** — Internal S A Graticule. **+$50**

**Option 08** — Protective front cover. (Cabinet only). **+$115**

**Option 77** — (7603/R7603 Only) GM (P7) Phosphor and Internal Spectrum Analyzer Graticule. **+$100**

### OPTIONAL ACCESSORY

**Blank Plug-In Panel** — Order 016-0155-00 **$50**




## 7K11 CATV Preamplifier

### 75 Ω Input Impedance and Calibration in dBmV

### Extra Sensitivity for CATV and Field Intensity Measurements

This 7000 Series plug-in preamplifier is for use with the 7L12 or 7L14 and tailored to CATV and field intensity measurement applications, where extra sensitivity is required for demanding measurements. The 7K11 handles 12 channels without overload.

The 7K11 provides a 75 Ω input impedance and calibration in dBmV. Its low noise figure makes it especially suitable for signal-to-noise and low-level radiation measurements.

### CHARACTERISTICS (WITH 7L12 or 7L14)

**Frequency Range** — 30 MHz to 890 MHz.

**Display Flatness** — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

**Sensitivity** — Signal + noise = 2X noise, in Lin mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is ≤5 dB.

**Intermodulation Distortion** — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

**Reference Level** — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

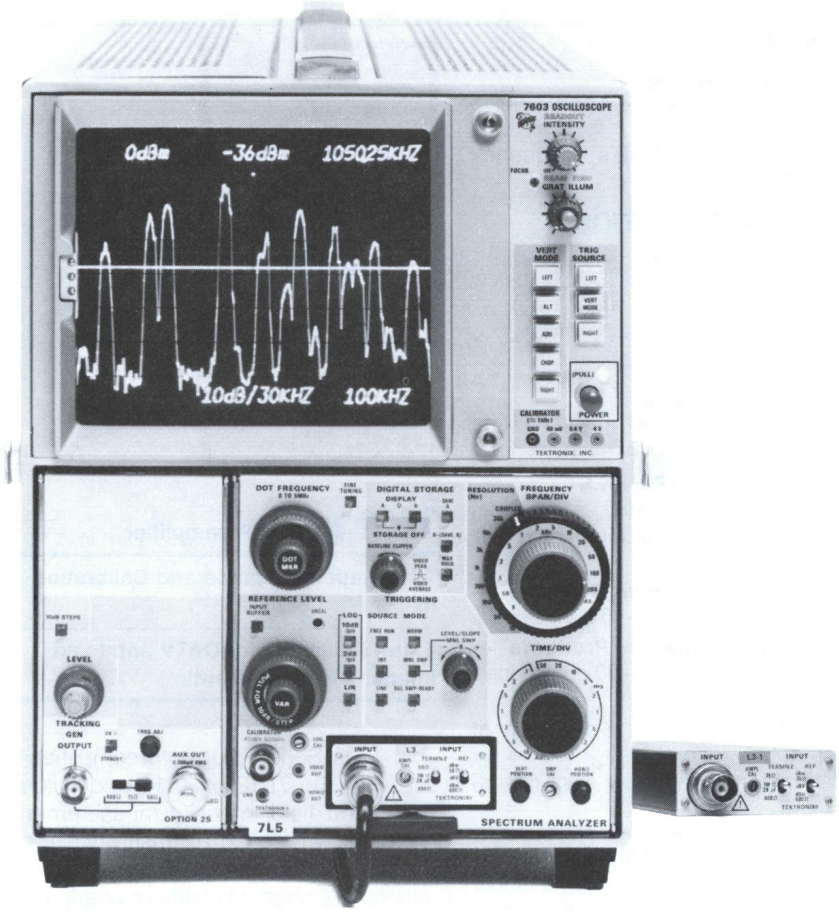
**Input Impedance** — 75 Ω.

**Calibrator** — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

### ORDERING INFORMATION

**7K11** CATV Preamplifier **$1,100**

**Includes:** 5.5 inch BNC to BNC 50 Ω cable (012-0214-00); BNC to F adaptor (013-0126-00); 42 inch BNC to BNC 75 Ω cable (012-0074-00); instruction manual (070-1664-00).




*7L5 Option 25 Spectrum Analyzer with L3 (50 Ω, 600 Ω, 1 mΩ) plug-in module in a 7603 Option 06 mainframe with internal spectrum analyzer graticule. The L3-1 module (shown at right) is switch selectable to 75 Ω, 600 Ω or 1 MΩ.*

# 7L5

**Synthesizer Tuning**

**Digital Storage and Averaging**

**Three-Knob Operation**

**Preset Reference Level and Dot Frequency for Extra Input Protection**

**Swept Measurements (Option 25 Tracking Generator)**

**Selectable Input Impedance; Calibration in dBm, dBV or Volts/Division**

**Semiautomatic Measurements with the Tek 7854**

The Tektronix 7L5 is a high performance, high value spectrum analyzer providing easy-to-use low frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

Digital storage proves particularly useful in the 7L5. With digital averaging and peak detection, you can accurately measure low level signals, such as intermodulation distortion products, in the presence of noise. With Max Hold, you can capture short duration signals and random transient phenomena that would otherwise be lost.

The 7L5 combines high performance with easy-to-use three-knob operation —
1) Set frequency span
2) Set center frequency
3) Set reference level...and measure!
Sweep speed and resolution bandwidth are set automatically.

Digital tuning and synthesizer stability let you set center frequency with six-digit accuracy immediately upon turn-on. Reference level can be set in 1 dB and 10 dB steps, eliminating the need to interpolate amplitude levels. And for measuring wide relative amplitude differences, the 7L5 offers 80 dB spurious-free display dynamic range.

The 7L5 makes accurate baseband communications measurements such as noise, spurious response, distortion, and transient interference, all with the certainty of 10 Hz resolution. The 7L5 Option 25 provides swept frequency measurements from 20 Hz to 5 MHz. The tracking generator is built into a "three-wide" 7L5 plug-in analyzer.

This highly capable audio/baseband analyzer finds a place in many areas of use, including measurement of communications system basebands, power line distortion, EMC/RFI, and computer systems.

Make semiautomatic measurements by using the Tek 7854 Digitizing Mainframe. This programmable unit's calculation and marker capabilities can greatly enhance your productivity using the 7L5 Spectrum Analyzer. Specify 7L5 Option 12 for proper 7854 interface. Get full details from your Tek sales engineer or ask for Application Note Number 26W-5653.

## CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer after a warm-up period of ten minutes.

### FREQUENCY RELATED

**Center Frequency Range —** Input Frequency Range: 20 Hz through 5.0 MHz.
Dot Frequency Range: 0 Hz through 4999.75 kHz tuned in 10 kHz or 250 Hz steps.
Accuracy at 0°C to 50°C: $\pm(20\text{ Hz} + 10^{-5}$ of dot frequency). 20°C to 30°C: $\pm(5\text{ Hz} + 2 \times 10^{-6}$ of dot frequency).

**Frequency Span/Division Range —** 50 Hz/div to 500 kHz/div (maximum) in a 1-2-5 sequence.
Accuracy: Within 5%.
Linearity: Within 5% over the center eight divisions.
Zero Span: Provides fixed frequency operation for time domain display.

**Resolution Bandwidth (6 dB) —** 10 Hz to 30 kHz in eight steps. Coupled position electronically couples resolution to span/division selection so that both are controlled by the same knob.
Accuracy: Within 20% of resolution selected (30 Hz to 30 kHz). 10 Hz is 100 Hz ±20 Hz 70 dB down.

**Resolution Shape Factor (60/6 dB) —** 10:1 or better for 10 Hz to 1 kHz and 5:1 or better for 3 kHz to 30 kHz.

**Signal Level Change Between Any Two Bandwidths —** 30 kHz to 100 Hz: ≤0.5 dB. 30 kHz to 10 Hz: ≤2.0 dB.

**Residual FM —** ≤1 Hz (p-p) for frequency span of 50 Hz/div to 2 kHz/div. ≤40 Hz (p-p) for frequency span of 5 kHz/div to 500 kHz/div.

**Stability —** ≤5 Hz/hour.

### AMPLITUDE RELATED

**Display Modes —**
Log 10 dB/Division: Provides 80 dB display dynamic range. Accuracy is within 0.08 dB/dB to 2 dB maximum over 80 dB display dynamic range.
Log 2 dB/Division: Provides 16 dB display dynamic range. Accuracy is within 0.15 dB/dB to 1 dB maximum over 16 dB display dynamic range.
LIN: 20 nV/div to 200 mV div in a 1-2-5 sequence. Accuracy is within 5%.

**Reference Level —** +21 dBm to −128 dBm (50 Ω or 75 Ω input impedance), +10 dBm to −139 dBm (600 Ω input impedance), +8 dBV to −141 dBV (1 MΩ input impedance). Calibrated in 1 dB and 10 dB steps.

**Display Flatness —** 0.7 dB maximum from 20 Hz to 5 MHz, (add 0.5% quantization error in digital storage).

**Sensitivity —** Equivalent input noise for each resolution bandwidth setting is measured in video average mode with 10 s/div sweep rate and input buffer control off. Sensitivity is degraded an additional 8 dB when the input buffer is on.

| Resolution Bandwidth | Averaged Noise Level | |
|---|---|---|
| | dBm 50 Ohm | dBV 75 Ohm |
| 10 Hz | −135 dBm | −140.5 dBV |
| 30 Hz | −133 dBm | −138.5 dBV |
| 100 Hz | −130 dBm | −135.5 dBV |
| 300 Hz | −125 dBm | −130.5 dBV |
| 1 kHz | −120 dBm | −125.5 dBV |
| 3 kHz | −115 dBm | −120.5 dBV |
| 10 kHz | −110 dBm | −115.5 dBV |
| 30 kHz | −105 dBm | −110.5 dBV |

### SPURIOUS RESPONSES

**Residual —** ⩽−143 dBV (noncalibrator related, referenced to the input).

**Intermodulation Products —** Within any frequency span for two on screen signals of any input level, third order down 75 dB or more and second order down 72 dB or more; of any input level up to −53 dBV or of any input level with input buffer on, second and third order down 80 dB or more.

### GENERAL CHARACTERISTICS

**Sweep —** Triggered, manual, auto.

**Sweep Time —** 10 s/div to 0.1 ms/div in a 1-2-5 sequence.

**Accuracy —** Within 5% of selected time/division.

**Triggering —** Sources are free run, internal and line. Modes are normal, manual sweep and single sweep.

**Sensitivity —** ⩾1.5 div of internal signal for both normal and single sweep modes over the approximate frequency range of 30 Hz to 500 kHz.

**Shipping Weight —** 7.6 kg (17 lb).

### INPUT SIGNALS

**Maximum Input Power Level —**
1 MΩ/28 pF: 15 V (p-p) for ac or pulse signals with risetimes of 2 V/μs or faster (pulses or ac beyond this specification may open an input fuse). 40 V (dc plus peak ac) for signals with risetimes slower than 2 V/μs.
600 Ω (Internally Terminated): 12 V dc or RMS (+24 dBm).
50 Ω (Internally Terminated): 3.5 V dc or RMS (+24 dBm).
Input Impedance: Switch selectable 1 MΩ in parallel with 28 pF, 50 Ω (75 Ω for L3 Option 01) termination, or 600 Ω termination.

### OUTPUT SIGNAL

**Calibrator —** (Cal Out) 500 kHz squarewave within ±0.15 dB of −40 dBV into the plug-in impedance.

**Video Out —** 50 mV/div ±5% (about the CRT center) with source impedance of 1 kΩ.

**Horizontal Out —** 0 V dc to about −6 V dc sawtooth with a source impedance of 5 kΩ.

## Option 25 Tracking Generator

The 7L5 with Option 25 Tracking Generator, provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 20 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a three-wide unit for the 7000 Series mainframes.

### CHARACTERISTICS

**Frequency Range —** 20 Hz to 5.0 MHz.

**Output Impedance —** 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

**Amplitude —** The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

**Range —** 50 Ω: 0 dBm to −63 dBm. 75 Ω: −6 dBm to −69 dBm. 600 Ω: −17 dBm to −80 dBm.

**Accuracy (Maximum Output Calibrated at 500 kHz) —** 50 Ω: 0 dBm ±0.25 dB. 75 Ω: −6 dBm + 0.4, −0.2 dB. 600 Ω: −17 dBm +0.5, −0.1 dB.

**Attenuator —** Range: 0 dB to 63 dB in 10 dB or 1 dB steps. Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

**Flatness —** 50 Ω and 75 Ω: Within 0.5 dB p-p. 600 Ω: Within 1.0 dB p-p. Total System Flatness (7L5 with L3 Plug-in Module and Option 25) 50 Ω and 75 Ω: Within 1.0 dB p-p. 600 Ω: Within 1.25 dB p-p.

**Dynamic Range (7L5 with Option 25) —** ⩾110 dB.

**Residual FM (p-p) —** (7L5 with Option 25). Spans to 2 kHz/Div: 2 Hz. Spans 5 kHz/Div or Greater: 40 Hz.

**Stability —** 25 Hz/5 minutes after ten minute warm-up decreasing to 25 Hz/hour maximum after one hour.

**Spurious Suppression, 20 Hz to 5.0 MHz (Harmonic and Nonharmonic) —** 40 dB or more with respect to the carrier.

**Auxiliary Output —** ⩾200 mV RMS into 50 Ω.

### BALANCED INPUT TRANSFORMER

**Frequency Range —** 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

**Flatness —** 0.25 dB p-p maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

**Common-Mode Rejection —** 25 dB minimum (50 kHz to 3 MHz).

**Output Termination —** Switchable between 124 Ω, 135 Ω, and none for bridging or external termination.

**Connectors —** WECO (0.37 in with 0.090 center) on 0.625 in spacing for balanced input. BNC for single-ended output.

## ORDERING INFORMATION

**(L3 Plug-In Not Included)**

**7L5** Spectrum Analyzer (Requires L3 Plug-in Module) **$11,070**
**Includes:** Spectrum analyzer graticule (337-1159-00); (7000 Series), and (337-1439-01); (7603), light blue filter (378-0684-00); operator manual (070-1734-01); service manual (070-2184-01).

**OPTIONS**

**Option 11 —** L3 Plug-in Module Option 01 shipped with 7L5. **+$1,580**

**Option 12 —** 7854 Waveform Oscilloscope compatibility. **+$150**

**Option 20 —** L3 Plug-in Module shipped with 7L5. **+$1,580**

**Option 25 —** Tracking Generator. **+$1,560**

**L3** Plug-in Module, 1 MΩ, 50 Ω, 600 Ω **$1,580**
**Includes:** Instruction manual (070-2154-02).

**Option 01 —** (L3 Only) 1 MΩ, 75 Ω, 600 Ω. **NC**

**CONVERSION KIT**

**Tracking Generator —** To add to existing 7L5. Order 040-0810-04 **$1,850**

**RECOMMENDED MAINFRAMES**

**7854 —** Waveform Processing Oscilloscope, 400 MHz. (See page 318.) **$15,830**

**7603*[1] —** Oscilloscope, 100 MHz. (See page 201.) **$3,250**

**R7603*[1] —** Rackmount Oscilloscope, 200 MHz. (See page 201.) **$3,720**

*[1] *Suggested oscilloscope.*

**MAINFRAME OPTIONS (7603/R7603)**

**Option 06 —** Internal SA Graticule. **+$50**

**Option 08 —** Protective Front Cover (Cabinet only). **+$115**

**Option 77 —** GM (P7) Phosphor and Internal SA Graticule. **+$100**

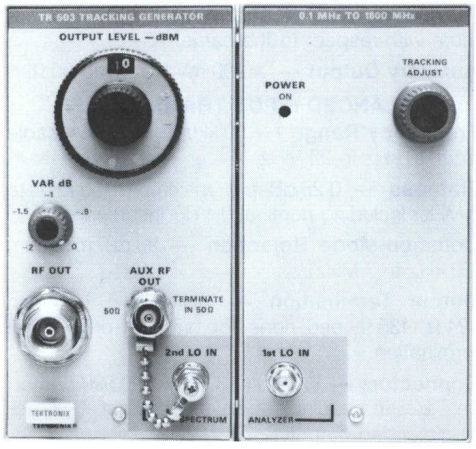
### OPTIONAL ACCESSORIES

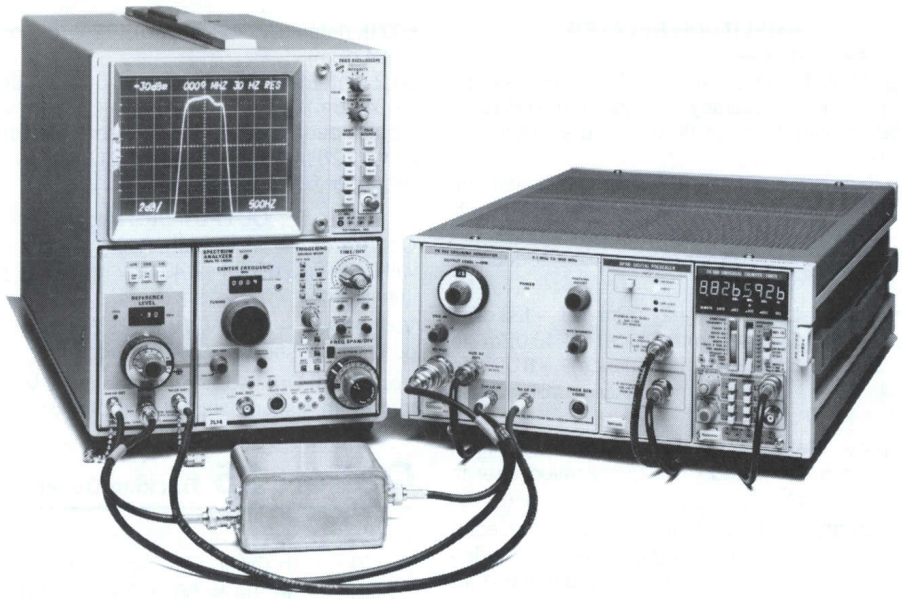
**75 Ω to 50 Ω Minimum Loss Attenuator —** Ac coupled. Order 011-0112-00 **$60**

**P6105A 10X Probe —** 2 m. Order 010-6105-13 **$110**

**Balanced Input Transformer —** Order 013-0182-00 **$300**

**Tektronix offers service training classes on the 7L5 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card.**



# TR 502/TR 503

## Tracking Generators

**Swept Measurements to 1.8 GHz**

**Enhances Dynamic Range to Better Than 110 dB**

**Very Stable—Resolve Signals Using 30 Hz Resolution Bandwidth**

**Auxilliary, Constant-Level Output Provides for Frequency Counter Measurement—Even of Signals at the Noise Floor**

*For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DP 501 Digital Prescaler and DC 509 Option 01 Digital Counter, in a TM 504 Power Module. The TR 502 is linked to the 1st and 2nd LO of a 7L14 Spectrum Analyzer in a 7603 mainframe.*

The TR 502 works with the 7L12 and 7L14 and the TR 503 works with all 490 Series spectrum analyzers to provide constant level, calibrated RF sources for swept frequency tests to 1.8 GHz.

The low residual FM of these systems enhances narrow bandwidth frequency response measurements. When used as a cw signal source with the analyzer in a manual mode, these systems have excellent frequency stability.

The tracking generators are two-wide units compatible with the TM 500 and TM 5000 Modular Instrument Series.

The TR 502/TR 503 Aux RF Output may be used to drive a frequency counter package, such as the recommended DP 501, DC 509 Option 01. Frequencies up to 1.8 GHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.

Dot marker frequency measurement capability may be obtained with the TR 502/7L14 Spectrum Analyzer. For more information concerning the dot marker capability, contact your local Tektronix sales engineer.

### OUTPUT CONNECTORS

**RF Out** — 0 dBm to −61 dBm signal source that tracks input frequency of spectrum analyzer. Output level is set by Output Level control and Var dB control.

**Aux RF Out** — For use with frequency counter.

## CHARACTERISTICS

| | TR 503/All 490 Series | TR 502/7L14 | TR 502/7L12 |
|---|---|---|---|
| **Frequency Range** | 100 kHz −1.8 GHz | 100 kHz −1.8 GHz | 100 kHz −1.8 GHz |
| **Output Level** | (Maximum) 0 dBm ±0.5 dB | 0 dBm ±0.5 dB | 0 dBm ±0.5 dB |
| **Range** | 0 to −59 dB in 10 dB and 1 dB steps | 0 to −59 dB in 10 dB and 1 dB steps | 0 to −59 dB in 10 dB and 1 dB steps |
| **Flatness** | Within ±2.25 dB Max from 100 kHz to 1.8 GHz (Typically ±1.5 dB) | Within ±2 dB maximum from 100 kHz to 1.8 GHz (Typically ±1.5 dB) | Within ±3.0 dB maximum from 100 kHz to 1.8 GHz (Typically ±2.0 dB) |
| **Dynamic Range** | ⩾110 dB | ⩾110 dB | ⩾100 dB |
| **Residual FM** | 50 Hz p-p | 13 Hz p-p | 200 Hz p-p |
| **Output Impedance** | 50 Ω Nominal, VSWR 2:1 or less to 1.8 GHz | 50 Ω nominal, VSWR 2:1 or less to 1.8 GHz | 50 Ω nominal, VSWR 2:1 or less to 1.8 GHz |
| **Auxiliary Output** | 0.1 V into 50 Ω load −7 dBm minimum | 0.1 V RMS into 50 Ω Load | 0.1 V RMS into 50 Ω Load |
| **Spurious Signoff** | Harmonic: −20 dBc Nonharmonic: −40 dBc | Harmonic: −20 dBc Nonharmonic: −40 dBc | Harmonic: −20 dBc Nonharmonic: −40 dBc |

## ORDERING INFORMATION

**TR 502** Tracking Generator **$6,620**

**Includes:** Two 50 Ω coax cables (012-0649-00); logic interface cable (012-0648-00); N male to BNC female adaptor (103-0045-00); retainer plug-in (343-0604-00); 3 mm male to BNC female adaptor (015-1018-00); instruction manual (070-1735-00).

**TR 503** Tracking Generator **$6,620**

**Includes:** Same as TR 502 except no logic interface cable and instruction manual (070-3526-00).

## OPTIONAL ACCESSORIES

**TM 503** — (TR 503 only) Power Module. **$390**

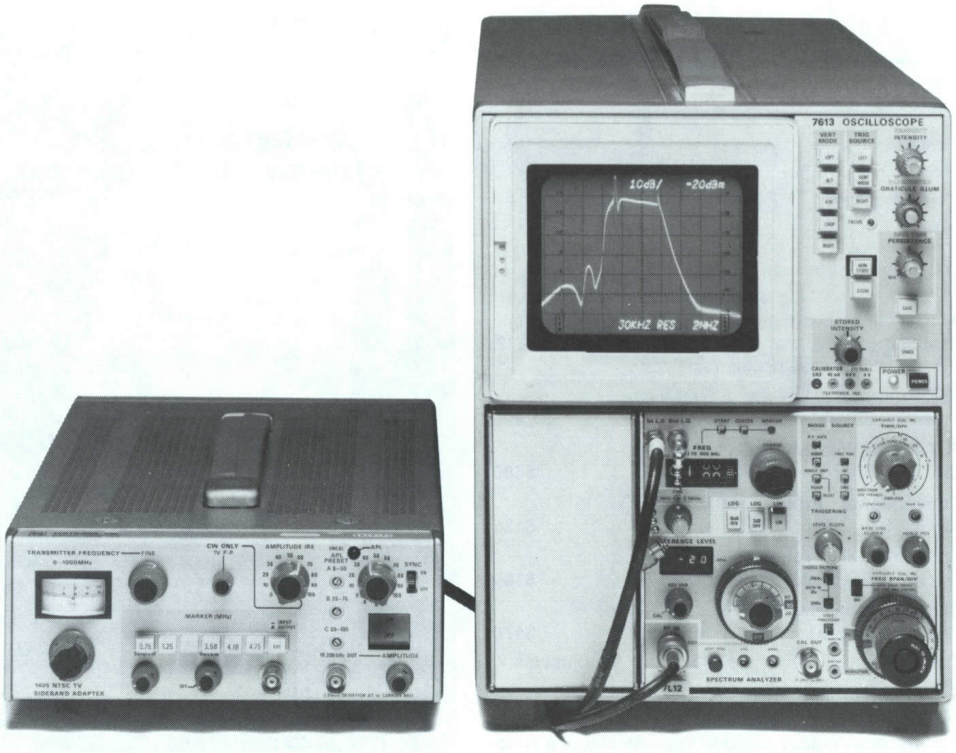
**TM 504** — (TR 502 only) Power Module. **$480**

**DC 509 Option 01** — Digital Counter with high stability time base. **$2,475**

**DP 501** — Digital Prescaler. **$575**

**Blank Panel** — Order 016-0195-03 **$25**

**10 dB, 3 mm Attenuator** — Used in the 2nd LO input line to improve TR 502/7L12 Isolation. Order 307-0553-00 **$44**




*1405/7L12 TV Sideband Adaptor Analyzer System*

## 1405 TV Sideband Adaptor

**Facilitates in-Service Testing of Transmitter**

**Measure Transmitter Frequency Response to ±0.2 dB**

**Video Circuits Can Be Swept**

**For In-Service Testing, Use of External Blanking Allows Either Full-Field or Single-Line Operation**

**Check Aural Fm Deviation with Built-In Bessel Null Technique**

**Flexible Marker System Will Accept Standard Crystals**

To analyze the sideband response of a television transmitter, the 1405 Sideband Adaptor is recommended for use in tandem with the Tektronix 7L12, 7L14, and all 490 Series spectrum analyzers. It generates a composite video signal, which is applied as modulation to a television transmitter. The output is displayed on the spectrum analyzer and appears as a response curve, to within ±0.2 dB, of the transmitter being tested.

The 1405/Spectrum Analyzer combination will display frequency-response characteristics of RF and IF circuits for transmitters with frequencies to 1 GHz. Video circuits can also be analyzed.

Option 02 provides the correct frequencies at the TV Channel marks on the dial readout so that it is ready for use with the 490 Series spectrum analyzers when shipped from the factory.

## CHARACTERISTICS

The following characteristics apply to the 1405, 1405/7L12 or 7L14 combination and 1405/490 Series combination. They are applicable over the environmental specification limits for the 1405 and 7000 Series mainframes.

### FREQUENCY (FREQUENCY OFFSET)

**Range** — Will tune and provide a swept video output for a center frequency range of 0 GHz to 1 GHz.

**Frequency Dial Accuracy** — Dial reading is within 20 MHz of transmitter frequency when properly tuned.

**Fine Tuning Range** — From ±0.5 MHz to ±1.25 MHz, depending upon transmitter frequency setting.

**Tuned Frequency Drift** — <1 MHz/hour after a 30 minute warm-up.

### OUTPUT SIGNAL LEVEL

**Amplitude (Sync Off)** — 100 IRE equals 0.714 V p-p when terminated in 75 Ω.

**Output Impedance** — 75 Ω ±1% at 100 IRE and ±2% from 0 IRE to 90 IRE.

**Variable** — 0 IRE to 100 IRE in 10 IRE steps.

**Accuracy (at 200 kHz)** — ±1 IRE at 100 IRE; ±2 IRE from 10 IRE to 90 IRE.

**Output Level During Blanking** — 0 V ±0.01 V at 0 IRE; 0 V ±0.04 V at 100 IRE from 0 MHz to 1 MHz; 0 V ±0.02 V at 100 IRE above 1 MHz.

**Cw Output Harmonics** — Third harmonic content down 40 dB from 0.1 MHz to 5 MHz; down 35 dB from 5 MHz to 10 MHz.

### FLATNESS

**1405** — Within ±0.1 dB from 100 kHz to 10 MHz, within ±0.2 dB from 10 MHz to 15 MHz, within ±0.4 dB from 50 kHz to 20 MHz.

**1405 Plus 7L12, 7L14, All 490 Series**

For Transmitter Frequency >20 MHz: Within ±0.2 dB from 100 kHz to 10 MHz of picture carrier, increasing to ±0.3 dB at 15 MHz; within ±0.5 dB from 50 kHz to 20 MHz.

For Transmitter Frequency of 0 MHz to 20 MHz: Within ±0.5 dB from 100 kHz to 15 MHz.

**System Span** — ≥200 kHz/div.

**Video Frequency Range** — 15 MHz to 0 MHz to 15 MHz.

### APL (AVERAGE PICTURE LEVEL)

**Variable** — 0 IRE to 100 IRE in 10 IRE steps.

**Accuracy** — ±2 IRE.

**Three Preset Levels** — Preset A: 0 IRE to 50 IRE. Preset B: 25 IRE to 75 IRE. Preset C: 50 IRE to 100 IRE.

**Horizontal Sync, Blanking, and Pedestal Duration** — Within NTSC (PAL — Option 01) limits (no vertical interval is provided). Transition time is 0.24 μs ±10%, from 10% to 90% points.

**Composite Sync Source Blanking** — 0 V turns cw on >−5 V turns cw off.

**Line Strobe** — TTL pulse from 0 V to 5 V turns cw on.

### AURAL OUTPUT

**Output Frequency** — 10.396 kHz: ±0.01% (crystal controlled). Option 01: 9.058 kHz.

**Cw Output** — Amplitude variable up to ≥+12 dBm into 600 Ω. Harmonics down 45 dB or more.

**Crystal Requirements** — Series Resonant: $R_2$ <2000 Ω; Q >5000; Case, HC/6U or HC/25U.

### MARKER CRYSTAL INSTALLATION

Because of the various international standards, the 1405 Option 01*[1] is shipped with the marker crystals installed. Frequencies installed are 0.75 MHz, 1.25 MHz, 2.25 MHz, 4.43 MHz, 5.00 MHz, and 5.75 MHz. Additional crystals are shipped with the unit.

*[1] *Option 01 instruments are connected for a nominal power line voltage of 240 V. They are furnished with the standard North American plug unless Options A1, A2, A3, A4, or A5 is specified.*

## ORDERING INFORMATION

**1405** TV Sideband Adaptor 525/60 Markers **$5,780**

**Includes:** Instruction manual (070-2078-00).

**Option 01** — TV Sideband Adaptor (625/50 Markers). **+$200**

**Option 02** — (Dial Readout for Use with 490 Series). **NC**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES

**Rackmount-Conversion Kit** — For Mounting 1405 or 1405 Option 01 in standard 19 inch rack. Order 016-0489-00 **$475**

### POWER SPLITTER

**75 Ω/50 Ω BNC Output, 50 Ω BNC Input** — Order 067-1232-00 **$250**

### CABLES, PADS AND ADAPTORS

**Calibrator Jumper Cable** — 50 Ω BNC to BNC 5.5 in. Order 012-0214-00 **$40**

**Jumper Cable** — BNC to BNC 50 Ω 42 in. Order 012-0057-01 **$17**

**Jumper Cable** — BNC to BNC 75 Ω, 42 in. Order 012-0074-00 **$17.50**

**75 Ω to 50 Ω Minimum Loss Attenuator** — With dc block, 5.7 dB loss. Order 011-0112-00 **$60**

**75 Ω to 50 Ω Matching Attenuator** — With 11.25 dB conversion factor from dBm to dBV with dc block. Order 011-0118-00 **$65**

**Fixed 10 dB Attenuator** — With 3 mm fittings for use with TR 502 with 7L12. Order 307-0553-00 **$44**

**"F" Female to BNC Male Adaptor** — Order 013-0126-00 **$16**

**BNC Female to "F" Male Adaptor** — Order 103-0158-00 **$11**

**"N" Female to BNC Male Adaptor** — Order 103-0058-00 **$7.00**

### DC BLOCKS

**BNC to BNC** — Maximum dc potential 50 V. Order 015-0221-00 **$85**

**N(F) to N(M)** — 10 kHz to 21 GHz 50 dc maximum. Order 015-0509-00 **$250**

### PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe.

**7000 Series 3 Hole Mainframe Cover** — Order 016-0192-01 **$20**

**7000 Series 4 Hole Mainframe Cover** — Order 016-0531-00 **$15**

**490 Series Rear Panel Connector Cover** — Order 337-3274-00 **$5**

### RIGID FRONT COVERS

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613.

**Protective Front Cover for existing 7603 or 7613 Mainframes:**

**Blue** — Order 040-0835-00 **$175**

**Gray** — Order 040-0628-00 **$175**

### GRATICULES, FILTERS

**Plastic Implosion Shield and S A Graticule** — 7613 and 7623 Mainframes. Order 378-0625-07 **$12**

**Plastic Implosion Shieid and S A Graticule** — 7403 and 7603 Mainframes. Order 337-1439-01 **8.00**

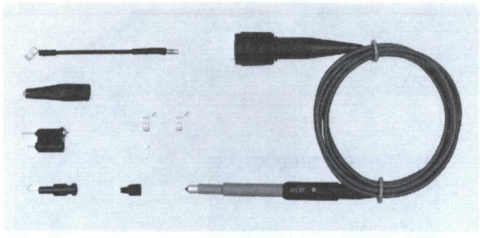
**Plastic Implosion Shield and S A Graticule** — For all other 7000 Series mainframes. Order 337-1159-02 **$8.00**

(Internal graticules are available with most 7000 Series mainframes).

**EMC Metal Screen Mesh Filter** — For 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 instruments. Order 378-0603-00 **$55**

**EMC Metal Screen Mesh Filter** — For 7400 Series and 7603 instruments. Order 378-0696-00 **$55**

Complete selection of colored filters is available in the accessories section, page 451.



### PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L5, 7L12, 7L14, all 490 Series spectrum analyzers.

**FET Probe P6201** — Dc to 900 MHz. Order 010-6201-01 **$1,220**

**FET Probe P6202A** — Dc to 500 MHz. Order 010-6202-03 **$680**

**Conventional Probe P6056** — Dc to 3.5 GHz 6 ft. Order 010-6056-03 **$185**

**Conventional Probe P6057** — Dc to 1.4 GHz with adaptor. Order 010-6057-03 **$190**

**Current Probe P6022** — Dc to 150 MHz. Order 015-0135-00 **$475**

Complete specifications are available in the probes and accessories section, page 425.

### CAMERAS

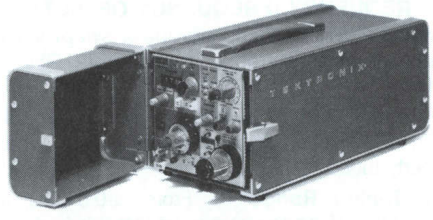
A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 7000 and 490 Series spectrum analyzers are:

**C-59AP** — General Purpose Camera. **$1,335**

**C-5C** — Low Cost Camera. **$495**

**C-4 Option 02** — Low Cost Camera. **$370**

Complete specifications on all cameras are available in the camera section, page 404.



### CARRYING CASES AND MOUNTS

Specialized carrying cases are available in two forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L5, 7L12, 7L14 or 7L18 plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

**Securing Kit** — Fits 7L12 or 7L14. Order 016-0637-00 **$65**

**3-Wide Carrying Case** — For 7L14, 7L5 Option 25, 7L18. Order 016-0626-00 **$350**

**2-Wide Carrying Case** — For 7L12, 7L5. Order 016-0625-00 **$315**

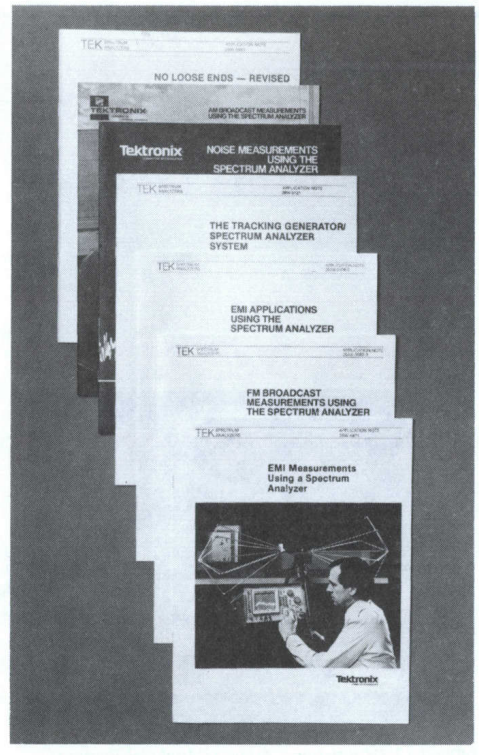
**Luggage-Type Carrying Case** — For 7603 Option 08, 7613 Option 08. Order 016-0628-00 **$530**

(Analyzer must have 016-0637-00 Securing Kit) **$65**

**Hard Case** — Transit for the 490 Series. Order 016-0658-00 **$725**

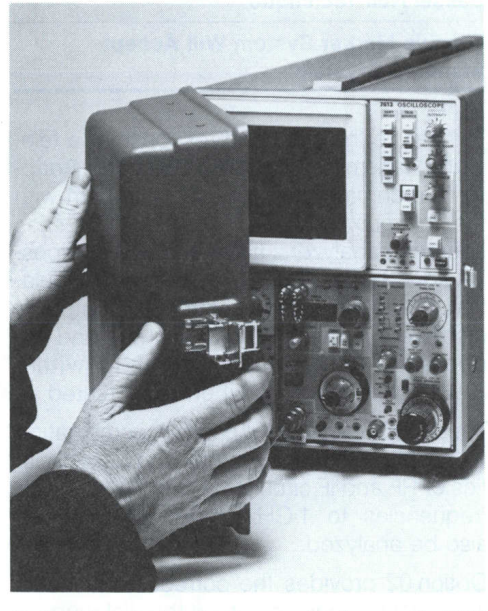
**Soft Case** — For the 490 Series. Order 016-0659-00 **$100**

Your local sales office or representative can quote prices and availability on any of these accessories.




Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMC, AM, FM, two-way radio and television measurements, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix sales office or representative.



*Option 08 protective front cover is shown with 7613 mainframe.*

# INSTRUMENTS/SYSTEMS PRODUCTS

## CONTENTS


Laboratory Oscilloscopes ..... 187
Portable Oscilloscopes ..... 253
Automated Test Systems Instruments ..... 294
Digitizers ..... 306
Acquisition/Processing Systems ..... 330
GPIB Programmable Instruments ..... 338
Modular Test and Measurement Instruments ..... 357
Curve Tracers ..... 393
Cameras ..... 404
Digital Photometer/Radiometer ..... 417
Carts ..... 422
Probes ..... 425
Isolation Measurement Accessories ..... 436
Probe Accessories ..... 446
Adapting/Connecting Accessories ..... 448
Mounting/Viewing Accessories ..... 450


**Broadest Selection**
We've added new capabilities to the world's broadest selection of portable and laboratory oscilloscopes, programmable and manual general purpose instruments, waveform digitizers, instruments and systems and accessories.

These additions illustrate our continuing commitment to make your time and resources more productive. Here are some examples:

**Software**
GURU supplies the important communication link between an IBM PC (or PC compatible) and GPIB instrumentation. See page 305.

EZ-TEST 4041 software package helps produce automated test and measurement system programs quickly and easily for the novice programmer. See page 304.

TekMAP library of software supports the 7000 Series digitizers.

To utilitize your 7D20 to its fullest potential, choose from two software packages which provide automated pulse parameter analysis, FFT, propagation delay measurements and storage/retrieval of waveforms. See page 315.

The 7854/IBM PC COMMUTE provides quick access to basic utilities for instrumentation and control. This software supports a 7854 and IBM PC (or PC compatible) and a Tek GURU or National GPIB board. See page 318.

**Portable Digitizers**
The 2430 brings the best features of the industry standard 2400 Series into the digital world. Tek's new patented feature, Save on Delta, provides unattended pass/fail testing. See page 307.

The 2230 and 2220 each feature 4 k record lengths, 100 ns peak detection and optional GPIB or RS-232C interfaces. See page 310.

**Automated Test Systems Instruments**
The 4041DDU Disk Drive Unit provides additional mass storage, operating efficiency and flexibility for the 4041 System Controller.

**Acquisition/Processing Systems**
Three new systems combine state-of-the-art waveform acquisition capabilities with computer processing and software control. For a Portable Measurement Package, the MP 2601 features the new 2430 Digital Oscilloscope and 4041 Controller. A complete Audio Measurements Package is found in the MP 2902, which couples the AA 5001, SG 5010, TM 5006 Mainframe, 4105A Computer Terminal and 4041. The new Oscilloscope Measurement Package, the MP 2903, brings together a 2465DVS (or 2465DMS or 2465CTS) and 4105A Computer Terminal, 4041 Controller and Tek EZ-TEST software.

**Probes**
The P6102A is a miniature 10X passive probe specially designed for full compatibility with all scopes employing 1 MΩ, 47 pF inputs.

Quick Delivery Probe — Five modular probes are now ready to ship within 24 hours: P6101A, P6105A, P6106A, P6122, P6131.

**Accessories**
The Travel Line Package for the Portable scopes provides added protection along the front and rear. This package includes accessory pouch, front panel cover, and carry strap.

# CONTENTS


| | Page |
|---|---|
| **Laboratory Oscilloscopes** | 187 |
| 7000 Series Instruments | 187 |
| 7000 Series Nonstorage Mainframes | 193 |
| 7000 Series CRT Storage Mainframes | 205 |
| 7000 Series Plug-Ins | 212 |
| 5000 Series Instruments | 238 |
| 7000/5000 Series Digitizers | 306 |
| 7000 Series Digitizer Plug-In | 315 |
| **Portable Oscilloscopes** | 253 |
| Portable Nonstorage Scopes | 256 |
| Portable Storage Scopes | 288 |
| GPIB Scopes | 259, 307, 310, 313, 318, 328 |
| **Automated Test Systems/Instruments** | 294 |
| Software | 297 |
| Controllers | 298 |
| SPS BASIC Software | 301 |
| Controller Peripherals | 303 |
| EZ-TEST Software | 304 |
| GURU Software | 305 |
| **Digitizers** | 306 |
| Digital Storage Oscilloscopes | 307,310 318, 328, 313 |
| **Acquisition/Processing Systems** | 330 |
| Desktop Controller Based Acquisition/ Processing Measurement Packages | 332 |
| Acquisition/Processing Measurement Systems | 337 |
| **GPIB Programmable Instruments** | 338 |
| Counter/Timers | 340 |
| Digital Multimeter | 344 |
| Function Generator | 345 |
| Power Supplies | 346 |
| Distortion Analyzer, Oscillator | 348 |
| Multifunction Interface, Function Cards | 350 |
| Oscilloscopes | 259, 307, 310, 313, 318, 328 |
| Scanner, Multiplexer | 354, 355 |
| TM 5000 Mainframes & Accessories | 355 |
| **Modular Test & Measurement Instruments** | 357 |
| Counter/Timers | 358 |
| Digital Multimeters | 363 |
| Pulse Generators | 367 |
| Function Generators | 370 |
| Digital Latch | 374 |
| Power Supplies | 375 |
| Distortion Analyzer | 377 |
| Oscillator | 378 |
| Current Amplifier, Probes | 379 |
| Amplifiers | 380 |
| Plug-In Oscilloscopes | 381 |
| Oscilloscope Calibration Generators | 385 |
| TM 500 Mainframes & Accessories | 389 |
| **Curve Tracers** | 393 |
| **Digital Photometer/Radiometer** | 417 |
| **Accessories** | 403 |
| Cameras | 404 |
| Carts | 422 |
| Probes | 425 |
| Isolation Accessories | 436 |
| Probe Accessories | 446 |
| Adapting/Connecting Accessories | 448 |
| Mounting Accessories | 450 |
| Viewing Accessories | 451 |


**REFERENCE INFORMATION**


| | Page |
|---|---|
| Increasing Productivity | 35 |
| Modular and Integrated Oscilloscopes | 176 |
| Programmable General Purpose Instruments | 177 |
| Understanding Oscilloscope Specifications | 178 |
| Choosing a CRT Phosphor | 180 |
| Storage Oscilloscopes | 182 |
| Digital Storage Oscilloscopes | 184 |
| Sampling Oscilloscopes | 185 |
| Waveform Digitizers | 186 |
| Automated Test System | 294 |
| Acquisition/Processing System Automation | 330 |
| Choosing a Scope Camera | 409 |
| Making Floating Scope Measurements | 436 |
| Choosing a Probe | 425 |


## A BROAD PRODUCT LINE

Tektronix designs, manufactures, markets, supports, and services test and measurement products worldwide. Our test and measurement instruments and systems are used by scientists, engineers, and technicians in basic research, product design, manufacturing test, training, maintenance, and service applications in a broad range of industries and public institutions.

Products include:

— Fully-automated desktop, controller and minicomputer-based acquisition/processing systems.

— The state-of-the-art laboratory 7000 Series plug-in instruments.

— The 5000 Series instruments, which continue the 7000 Series concept of flexibility and expandability with a line of plug-ins and mainframes for the cost-conscious user.

— A complete line of portable oscilloscopes that range from hand-held, battery-operated miniscopes to full-featured, high-performance instruments that have become the standards against which all other portables are measured.

— Two modular and compact product lines of general purpose instrumentation, including the cost-effective TM 500s and the GPIB-compatible and programmable TM 5000s.

— Curve tracers that acquire complete information about a multitude of semiconductor devices and integrated circuits and present it in a quickly comprehensible display.

— A portable digital photometer/radiometer with eight interchangeable probes for measuring illuminance, irradiance, luminance, LED output, and relative intensity.

— Accessories, from cameras to isolation measurement devices, that support not only all Instruments products, but also many Tek Design Automation, Information Display, and Communication products.

## MODULAR AND INTEGRATED INSTRUMENTS

There are two basic configurations for test and measurement instruments: modular and integrated. Modular instruments, also called "plug-in" or "laboratory" models, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments (also called "monolithic") are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all integrated instruments are portable, and some modular systems (such as scopes within the Tektronix TM 500 Instrument line) are designed for easy transport.

### Modular Design Advantages

Examples of modular design in Tektronix Instrument products include the 7000 Series, the 5000 Series, the TM 500 General Purpose Instruments and the TM 5000 Programmable General Purpose Instruments.

Versatility is the prime advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit are available by choosing the right plug-ins. Plug-ins can also extend the original instrument's range of functions. Digital multimeters, curve tracers, spectrum analyzers, and logic analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscope mainframes.

Performance is another advantage. In the case of the 7000 Series instrument, modularity gives you the maximum performance available in an oscilloscope. And modularity also allows you to upgrade your instruments to take advantage of advances in technology.

Modular instruments can often be very cost effective too, because within a given product line, they can be shared. For example the TM 500 test and calibration plug-ins used in the lab for design work can be inserted in a portable mainframe and easily carried to the site of a service problem. Or as another example, a few high-performance laboratory plug-ins from the 7000 Series can be shared among several 7000 Series mainframes.

Consider the versatility and performance advantages as you read about the wide range of Tektronix modular instruments: page 187 for the 7000 Series instruments, page 238 for 5000 Series instruments, page 338 for TM 5000 Programmable Instruments, and page 357 for TM 500 Test and Measurement Instruments.

**Integrated Design Advantages**

Integrated instruments are often optimized for a single range of functions. One-piece instrument design can provide reductions in weight, increased ease of use, smaller size, lower power requirements, and often, higher performance/price ratios for your key requirements.

Portability can be essential for some test and measurement applications, and in these cases, an integrated design is often the best choice. Because a wide variety of options and optional accessories extend their ranges of applications, versatility can also be a feature of Tektronix integrated instruments.

Tektronix integrated scopes, either portable or rackmounted, are instruments where the design emphasis is often on the factors of economy, ruggedness, environmental protection, and internal or external battery power. See page 253.

## TM 500 MANUAL INSTRUMENTS

The Tektronix TM 500 line is a modular system. One-, three-, four-, five-, and six-compartment mainframes accept a broad selection of plug-in instruments. The mainframe provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as important, TM 500 mainframes also provide a signal control and data interface between instrument modules. This allows TM 500 instruments to work either individually or together as integrated measuring systems. The Tektronix TM 500 Instrument line is extensive—more than 35 instruments, including digital multimeters, counter/timers, power supplies, signal sources, oscilloscopes, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can easily apply TM 500's capability to unusual applications.

The TM 500 instrument line has several configurations designed for portability. The TM 515 Traveler Mainframe, attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat on most airlines), is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. The TM 503 three-compartment mainframe or the TM 504 four-compartment mainframe, with carrying case or protective cover, provide additional portability for the TM 500 instruments. Again, relatively lightweight, rugged construction and convenient size are the key to portability.

## TM 5000 GPIB PROGRAMMABLE INSTRUMENTS

The Tektronix TM 5000 products extend the TM 500 concept of configurability to a line of IEEE Standard 488 compatible, fully programmable measurement, stimulus, and interfacing instruments. Tek's TM 5000 programmables are the easiest IEEE Standard 488 test and measurement instruments you can use. Because they are compatible with our TM 500 line of modular instruments, it is possible to configure literally hundreds of customized systems—systems that are programmable, manual, or hybrid—with plug-in, pull-out ease.

Tek's *Standard Codes and Formats* make communication between TM 5000 instruments easier than ever before. This same set of *Standard Codes and Formats* is used to communicate with other Tektronix IEEE Standard 488 instruments, such as the 2400 Family Oscilloscopes and 490P Series Spectrum Analyzers. TM 5000 commands are mnemonic. Each bus command is in "standard engineering English", matching the front panel nomenclature—ideal for the programmer who realizes the frustrations of working with many of today's instruments.

With the Learn Mode, one keystroke transfers a complete front panel setup to the controller for storage in memory. This greatly increases the productivity of the engineer by reducing setup time where test settings are constantly changing. You can change a routine without having to reprogram the whole system.

All TM 5000 programmables have diagnostics capability designed right in. They perform self-test on power-up, and indicate an error if a malfunction has occurred. Plus, they've all been designed for fast troubleshooting using signature analysis. All are UL listed.

As with TM 500, TM 5000 programmable systems take up less than half the space of standard rackmount equipment. This size advantage really pays off—on the bench, on the manufacturing floor, or in the field where portability is essential.

## GPIB OSCILLOSCOPES

Tektronix has several oscilloscopes to choose from for GPIB capability. The 7854, 2445/2465 Family, 2230, 2220, 2430, 336, and 5223 with their respective GPIB features or options, give you an opportunity to improve the consistency of measurements and control costs. A GPIB system controller can consistently repeat a defined sequence of tests while the operator concentrates on the task instead of the tools. A system comprising a GPIB controller and programmable oscilloscope offers complete automation of many measurements.

The 7854's keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines—with all mainframe keystroke functions and operating modes remotely controlled via the GPIB.

The 2445/2465 offers a Counter/Timer/Trigger option for automatically measuring frequency, period, pulse width, and time between events. Also, by combining the GPIB and Digital Multimeter options, this system can efficiently perform both waveform and steady state measurements. For a truly comprehensive measurement system, combine GPIB, Counter/Timer/Trigger, and DMM options.

Software development won't overwhelm your program if you use the built-in "Learn mode" of the 2445/2465 GPIB option to generate detailed setup instructions. With Tek EZ-TEST software from Tektronix, your controller will do more for you while demanding less programming effort.

There are two factory-installed options available for the 2230 (Not retrofitable):

GPIB (IEEE-488) Talker/Listener (Not fully programmable)

RS-232 Talker/Listener (Not fully programmable)

Waveforms, scale factor settings, and cursor data can be transported each way on bus. Only one bus can be installed at the time of order. The scope is not programmable; however, single-sweep reset and some limited storage functions are addressable to enable a "babysitting" application. The 2230 also includes 26K of battery-backed memory with either the RS-232 or GPIB option for additional waveform storage.

The 2220 is available with GPIB or RS-232 options, but does not have battery backed reference memory.

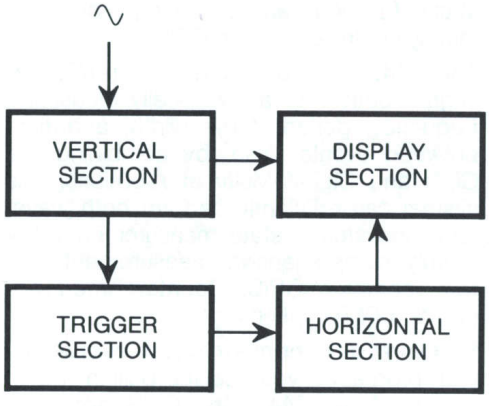
The compact 336 simultaneously displays real-time and digitally stored waveforms. An Auto mode allows "hands-off" operation in many applications.

The 10 MHz 5223 has a roll mode to provide a strip-chart-like view of signals at slow speed, the GPIB interface for I/O of stored waveforms and control of several digital storage functions.

## KEY OSCILLOSCOPE SPECIFICATIONS AND FEATURES

You should choose an oscilloscope by matching both performance and features to measurement applications. Don't choose by performance alone, because when features make measurements easier, the result is likely to be more accurate measurements. And if your applications involve repetitive measurements, features that make the measurement faster will be cost-effective.

The key oscilloscope specifications and features described below may help you make a decision.



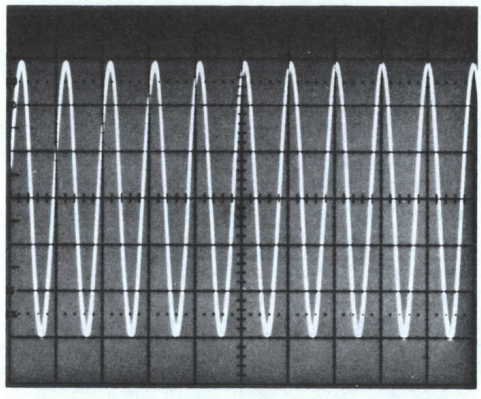

### Vertical System Considerations

Because a faithful reproduction of the signal is necessary for measurement accuracy, and because very small signals must often be measured, the key specifications of the vertical system include bandwidth and sensitivity.

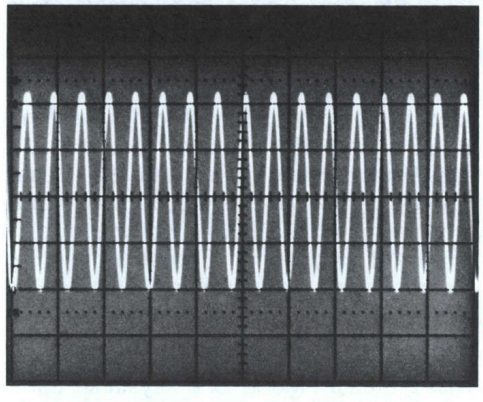
Depending on your applications, you might also want to consider oscilloscopes that display more than one signal at a time and those with differential or balanced inputs; these features are also described below.

### Bandwidth and Risetime

Bandwidth is the range of frequencies that a scope can handle with less than a 3 dB loss in amplitude compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, the bandwidth specification is commonly the highest frequency that can be displayed; dc as the lowest, is implied. The following figures illustrate bandwidth specifications.



*0 dB: 6 div at 50 kHz*



*−3 dB: 4.2 div at 100 MHz*

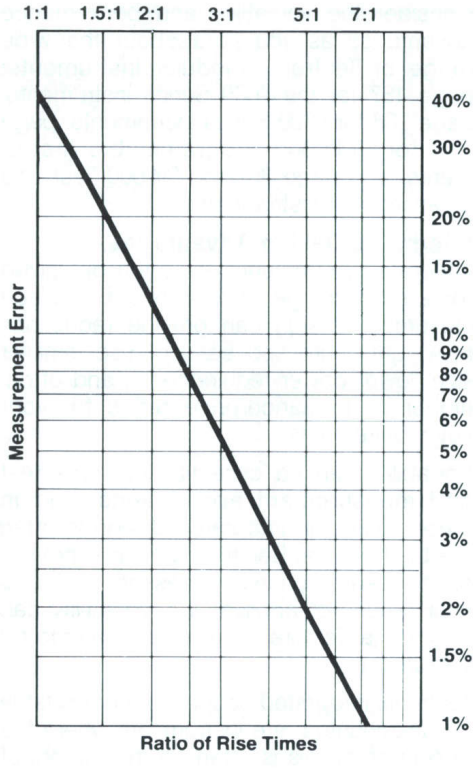
While a bandwidth specification is essential for the vertical system(s) of a scope, bandwidth is also sometimes specified for the horizontal system (which gives you a chance to evaluate performance in X-Y measurement applications) and for trigger systems (which permits you to determine the range of possible triggering signals).

Although bandwidth is the most important spec when making amplitude measurements, risetime is the specification to use if you are making timing measurements.

The frequency response of most scopes is designed so that there is a constant that allows you to relate the bandwidth and risetime of the instrument with this approximation:

$$T_r = \frac{0.35}{BW}$$

Given either specification (bandwidth or risetime), you can derive the other and determine if the instrument is suitable for your applications. The rule of thumb for timing measurements is to use an instrument with a risetime at least five times faster than the measurement you expect to make. A 5:1 ratio gives you a risetime measurement with ≤2% error. Other ratios and measurement errors are shown in the chart.




Note that very accurate absolute-risetime measurements are not always a requirement. When you are comparing risetimes, for instance, an instrument risetime equal to those being measured is often adequate.

### Sensitivity

An oscilloscope sensitivity specification describes the input signal level needed to produce a stated deflection of the electron beam within the CRT. Specifications typically are given in mV/cm or mV/div; with this spec you can determine if small signals will be displayed with enough amplitude for you to make measurements quickly and accurately.

Note that at a given state-of-the-art, sensitivity and bandwidth are trade-offs. The small amount of noise in even the best input circuit will mask very small signals. Raising the bandwidth also increases the noise picked up by the amplifiers, requiring a larger signal to create a clear display. As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make cleaner low-level measurements at moderate frequencies.

Although sensitivity specifications are most often associated with oscilloscope vertical channels, this specification can also be provided for horizontal systems and for trigger circuits.

### Multiple Inputs

It is often quite useful to be able to view more than one input signal without disturbing the connections to your scope. Common applications include: comparisons of a device's input and output signals; checking signals against standards; making timing and/or phase measurements between events. These measurement requirements are usually satisified by dual-trace oscilloscopes that use electronic switching to alternately connect two input signals to a single deflection system. Dual-trace scopes offer the lowest cost and the best comparison capabilities (because there is a single horizontal amplifier and one set of deflection plates). On the other hand, since a fast transient event might occur on one channel while the beam is tracing the other, dual-beam scopes like the Tektronix 7844 (page 203) and 5113 (page 244) are recommended for viewing single-shot phenomena. The 5113 has two independent vertical systems and a common horizontal system and can display up to eight waveforms in its Chop vertical operating mode. The dual-beam 7844 can be equipped with dual time base plug-ins and then used to see a single event at different locations in the signal path, at two sweep rates if necessary.

### Vertical System Operating Modes

Multiple inputs, the Add vertical operating mode, and the ability to invert one channel lets you cancel or reject any signal components equal in amplitude and phase that appear at both inputs. This ability provides a simple and accurate way to measure the difference between two signals, and of rejecting most unwanted signal components common to both inputs (such as power supply hum).

Other vertical operating modes are Alternate (in which a complete waveform from one vertical channel is drawn before switching to draw the other), Chopped (in which the scope draws small parts of the waveforms while switching back and forth between the channels at a fixed rate), and Trigger View.

The Trigger View mode is useful anytime you measure events dependent on an external triggering event.

### Horizontal System Considerations

The horizontal system of a modern oscilloscope provides a built-in sawtooth sweep generator. With this constant-speed horizontal deflection, measurements calibrated directly in units of time are possible. (As a consequence, the horizontal system of a scope is often called the time base.) This permits direct measurement of time between events, accurate time measurements on small portions of pulse trains, and even time measurements on single, nonrecurrent events.

### Sweep Speeds

How fast a sweep speed do you need? One rule states that for frequency measurements at moderate frequencies, a sweep capable of displaying one cycle across the full horizontal scale is usually considered adequate. For example, one cycle of a 10 MHz signal can be displayed across 10 div with a 10 ns/div sweep. Don't apply this rule at ultrahigh frequencies, however, as scopes seldom have sweeps that fast.

Another approach emphasizes risetime measurements. For maximum accuracy here, the scope should show the step signal (squarewave, pulse, etc.) across most of the full vertical scale with the rising portion of the signal at nearly a 45° slope. For very fast risetimes, this objective is rarely met because of compounding difficulties and the cost of providing extremely fast sweeps which are both linear and accurate.

Though neither rule can be applied at the very limits, fast sweep speeds are readily available: sweeps to 5 ns (500 ps/div magnified) in the portable 2465; to 200 ps/div with plug-in time bases for laboratory scopes; or to 10 ps/div with sampling plug-ins. (See Sampling Applications on page 185.)

### Delayed Sweep Measurements

Delayed sweep scopes can offer you many measurement advantages. If the scope has two calibrated time bases and the Alternate horizontal operating mode (electronic switching of the trace between time bases), then convenient comparisons of the same signal at two different sweep speeds are possible.

If the second time base has an independent trigger, then jitter-free measurements on the delayed sweep are possible.

In every case, timing measurements with delayed sweep are easier to make, and in most cases, there is increased timing measurement accuracy. Many plug-in time bases for laboratory scopes and most portable scopes offer delayed sweep.

### Accuracy

Accuracy in a scope's horizontal system is as important to timing measurements as vertical accuracy is to amplitude measurements. Horizontal accuracy to 1.5% is possible with several 7000 Series plug-in time bases and to 1% with the 2445 and 2465 Portable oscilloscopes.

### Probe Considerations

An oscilloscope can only display a waveform as accurately as it receives it. Thus, a high accuracy Tektronix probe will complete a measurement system by establishing this critical link between the scope and circuit under test.

A wide range of Tek probes available to solve your specific measurement problems are shown beginning on page 425.

### Trigger System Considerations

Besides sensitivity and bandwidth, the flexibility of a trigger system should be a consideration when choosing a scope. Some trigger system features you might need for your measurement applications include:

High and low frequency reject coupling — for stable triggering with noisy signals.
TV triggering — for automatic synchronization with video signals.
Alternate triggering — for steady display of either signal with dual-channel scopes.
Peak-to-peak auto triggering — for quick, convenient triggering with automatic level limits.
Variable trigger holdoff — permits trigger holdoff period to be varied to trigger on repetitive complex waveforms.
Single sweep operation — for special applications such as capturing a transient pulse and for CRT photography.

By combining logic analyzer triggering capabilities with an oscilloscope, digital signals can be displayed in analog form for measurements of time and amplitude. The 7A42 Logic Triggered Vertical Amplifier extends the 7000 Series triggering into the arena of logic analysis. The 2400 Series offers Counter/Timer/Trigger options and three Special Edition scopes to provide delay-by-events triggering and Boolean logic triggering.

### CRT System Considerations

CRT system specifications will tell you how well the scope can display waveforms for direct viewing and for photography. A full complement of CRT system controls contributes greatly to the instrument's ease of use.

### CRT Controls

CRT system controls to consider include:
Beam Finder — A single pushbutton that allows you to quickly locate any off-screen trace.
Auto Focus — Auto focusing on both laboratory and portable scopes reduces the need for manual readjustments with changes in trace intensity; very useful when traces are displayed at different sweep rates, as in the Alternate horizontal operating mode.
Auto Intensity — Maintains optimum trace intensity over a wide sweep-speed range.
External Z-Axis Input — Permits trace brightness modulation, makes some measurements easier by identifying events with an intensified zone on the trace.

## PHOTOGRAPHIC WRITING RATE

Photographic writing rate is a measure of the scope/camera/film's capability to record high speed signals.

Recording high speed signals on film is dependent on at least three factors: the oscilloscope used, film characteristics, and the camera. For maximum writing rate capability, the objective is to get as much light energy to the film surface as possible. Since each component affects photographic writing rate, the selection for top performance is important.

The fastest writing rate oscilloscopes available are the 7104/R7103. At 20 cm/ns, these scopes utilize a unique microchannel plate CRT with GH (P31) phosphor standard. The chart shown graphs the response of the 7104/R7103 along with other 7000 Series mainframes and the 485 portable oscilloscope. (The other instruments shown in the graph utilize optional BE (P11) phosphor to achieve the writing rate performance indicated.)

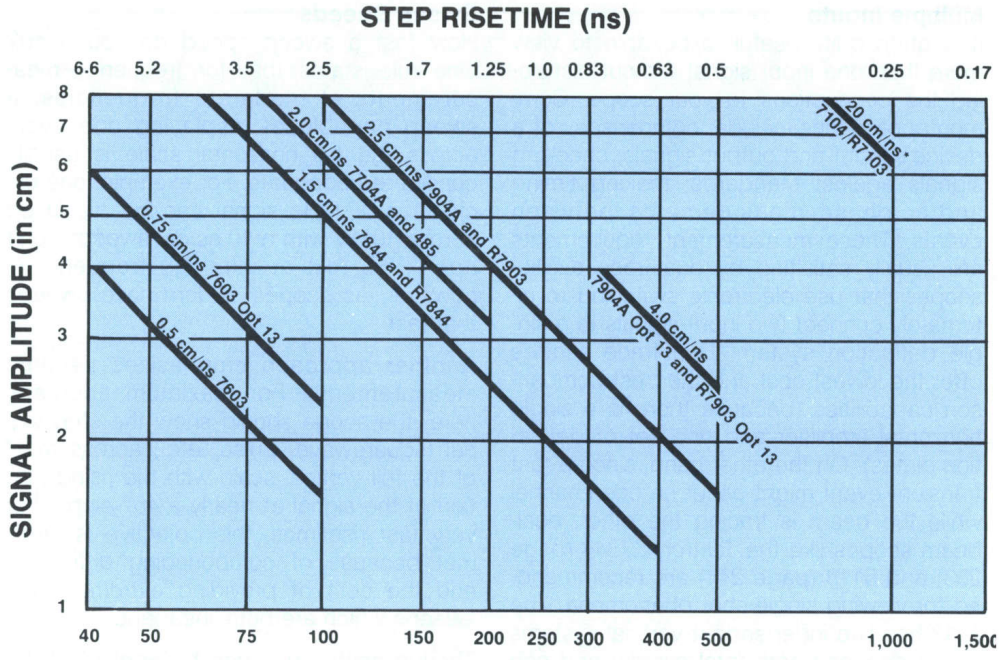
### Writing Rate Comparison Graph

On the graph, vertical signal amplitude on the vertical scale is shown against maximum sinewave frequency (lower scale) and fastest risetime (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The ramp is assumed to be a linear ramp measured between the 10% and 90% points.

There is an application note available from Tektronix which further describes photographic writing rate, including measurement procedures and applications. It is available on request by referencing 42W-5335-1.

### Selecting a Phosphor

The catalog description of each oscilloscope indicates the phosphors normally supplied or available as options. While a special phosphor may be desirable for a specific measurement application, remember that each phosphor has its own color, persistence, burn resistance, etc. Improvements in one characteristic are usually at the expense of others. The chart below provides comparisons.




*Amplitude vs speed and photographic writing speed comparison of 7000 Series mainframes using BE (P11) phosphors (Option 78). 20,000 ASA film and the C-51 (f/1.2, 1:0.5) Camera.*

*BE (P11) phosphor has a different spectral output than GH (P31) phosphor standard and more closely matches the sensitivity spectrum of silver halide film types. While photographic writing speed is approximately two times the GH (P31) rate, the visual output luminance is approximately 15% of GH (P31) phosphor standard, using Polaroid Film Type 107, 3,000 ASA w/out film fogging.*

** 20 cm/ns is the specified photographic writing speed for the 7104/R7103 Mainframe. However, it is not directly comparable to the other mainframes here because of relaxed phosphor, film and camera requirements. The microchannel plate CRT as well as the bright photographed image allow for these relaxed requirements. GH (P31) phosphor standard is used and a C-53 (f/1.9, 1:0.85 image) Camera, using Polaroid Type 107, 3,000 ASA without film fogging.*

*NOTE: A writing speed enhancer used to fog the film may increase the photographic writing speed.* *See page 405.*

### COMPARATIVE CRT PHOSPHOR DATA

| Phosphor*1 | | Fluorescence and Phosphorescence | Relative Luminance*2 | Relative Photographic Writing Speed*3 | Decay | Relative Burn Resistance | Comments | Ordering Information Option |
|---|---|---|---|---|---|---|---|---|
| WTDS | JEDC | | | | | | | |
| GJ | P1 | Yellowish-green | 50% | 20% | Medium | Medium | Replaced by GH (P31) in most applications | Special order |
| WW | P4 | White | 50% | 40% | Med-Short | Med-High | Television displays | 74 |
| GM | P7 | Blue*5 | 35% | 75% | Long | Medium | Long decay, double-layer screen | 76 |
| BE | P11 | Blue | 15% | 100% | Med-Short | Medium | For photographic applications | 78 |
| GH | P31 | Green | 100% | 50% | Med-Short | High | General purposes, brightest available phosphor | 80 |
| GR | P39 | Yellowish-green | 27% | NA*4 | Long | Medium | Low refresh rate displays | 40 |
| GY | P43 | Yellowish-green | 40% | NA*4 | Medium | Very High | High current density phosphor | Special order |
| GX | P44 | Yellowish-green | 68% | NA*4 | Medium | High | Bistable storage | |
| WB | P45 | White | 32% | NA*4 | Medium | Very High | Monochrome TV displays | |

**1 Tektronix is adopting the Worldwide Phosphor Type Designation System (WTDS) as a replacement for the older JEDEC "P" number system referenced in this catalog. The chart lists the comparable WTDS designations for the most common "P" numbers.*

**2 Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. GH (P31) as reference.*

**3 BE (P11) as reference with Polaroid 612 or 106 film. Representative of 10 kV aluminized screens.*

**4 Not available.*

**5 Yellowish-green Phosphorescence.*

### Camera Considerations

Tektronix manufactures a variety of cameras designed for use with oscilloscopes. Two key parameters are the f-number of the lens and the magnification. These parameters affect the light gathering capability of the camera. The chart utilizes a f/1.2 Tektronix C-51 Camera (f/1.9 Tektronix C-53 camera with the 7104). More information on cameras is available on page 404.

Film characteristics are also an important parameter. Generally, the higher the ASA rating of the film used, the higher the film sensitivity and thus, photographic writing rate. It should be recognized that film speed can vary with storage conditions and environmental factors. More information is available from film vendors.

### Writing Speed Enhancer

A writing speed enhancer provides controlled fogging of the film to increase its sensitivity. The degree of writing speed improvement is variable, and is dependent on the film, camera, and scope combination used. More information is available on page 405. A writing speed Application Note is also available by requesting 42W-5335-1.

## DIGITAL FEATURES INCREASE OSCILLOSCOPE PERFORMANCE

You can make delay and time interval measurement with digital ease on several Tektronix oscilloscopes. The 2400 Series offers Counter/Timer/Trigger options for the standard instrument and the three Special Edition 2465's. These CTT options provide crystal-controlled time base accuracy for several time related measurements and are fully integrated with the operation of the scope and user on-screen menus. The DM 44 factory-installed option for 466 Storage Oscilloscopes allows you to read the delay time, time interval, or frequency right from a LED readout, with no calculation or interpolation required. The DM 44 also incorporates a digital volt/ohm meter and temperature-measurement capabilities.

The 7B10, 7B15, 7B85 and 7B80 plug-ins for the 7000 Series oscilloscopes also provide Δtime measurements. With these plug-ins, the time interval measurement can be shown on the screen using the 7000 Series CRT readout capability.

For 7000 Series instruments, there are a wide variety of other digital plug-ins. These include a universal counter/timer, a digital multimeter with a temperature mode, digital delay by time or events, and a versatile 0.01% A/D converter with vertical amplifier.

Combining digital capabilities within the oscilloscope system offers many advantages over separate test units, such as: increased accuracy, scope-controlled digital measurements, measuring convenience and confidence, easier and faster solutions to complex problems, a lower dollar investment, more bench space, and signal conditioning.

### MODULAR NONSTORAGE OSCILLOSCOPES

| Product | Bandwidth*1 | Minimum Deflection Factor | Number of Traces | Maximum Sweep Rate | Delayed Sweep | Page | Price*2 |
|---|---|---|---|---|---|---|---|
| 7104<br>R7103 | 1 GHz | 10 mV/div at BW | up to 4 | 200 ps/div | X | 194 | $23,995<br>$24,520 |
| 7904A<br>R7903 | 500 MHz | 10 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 500 ps/div | X | 197 | $9,635<br>$9,330 |
| 7844<br>R7844 | 400 MHz | 20 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4<br>Dual-Beam | 1 ns/div | X | 203 | $14,995<br>$15,450 |
| 7704A<br>Opt 09 | 250 MHz | 20 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 2 ns/div | X | 199 | $5,495 |
| 7704A | 200 MHz | 10 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 2 ns/div | X | 199 | $4,995 |
| 7603<br>R7603 | 100 MHz | 5 mV/div at BW<br>10 μV/div<br>1 mA/div | up to 4 | 5 ns/div | X | 201 | $3,250<br>$3,720 |
| 5440<br>R5440 | 50 MHz | 5 mV/div at BW<br>10 μV/div<br>0.5 mA/div | up to 8 | 5 ns/div | X | 241 | $3,160<br>$3,225 |
| 5110<br>R5110<br>5116 | 2 MHz | 1 mV/div at BW<br>10 μV/div<br>0.5 mA/div | up to 8 | 100 ns/div | X | 244<br><br>246 | $1,650<br>$1,720<br>$2,460 |

*1 *Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
*2 *Price does not include plug-ins.*

### PORTABLE NONSTORAGE OSCILLOSCOPES

| Product | Bandwidth | Minimum Deflection Factor | Dual-Trace | Maximum Sweep Rate | Delayed Sweep | Page | Price |
|---|---|---|---|---|---|---|---|
| 485 | 350 MHz | 5 mV/div at BW | X | 1 ns/div | X | 256 | $9,100 |
| 2465<br>2465CTS*2<br>2465DMS*2<br>2465DVS*2 | 300 MHz | 2 mV/div at BW | 4 channel | 500 ps/div | X | 259 | $5,350<br>$7,150<br>$8,400<br>$9,200 |
| 2445 | 150 MHz | 2 mV/div at BW | 4 channel | 1 ns/div | X | 259 | $3,590 |
| 2337 | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 268 | $3,990 |
| 2336 | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 268 | $3,690 |
| 2336YA | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 268 | $3,890 |
| 2335 | 100 MHz | 5 mV/div at BW | X | 5 ns/div | X | 268 | $3,390 |
| 2235 | 100 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 274 | $1,750 |
| 2235 Opt 01 | 100 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 274 | $1,995 |
| 2236 | 100 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 272 | $2,650 |
| 2215A | 60 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 278 | $1,525 |
| 2213A | 60 MHz | 5 mV/div at BW<br>2 mV/div | X | 5 ns/div | X | 278 | $1,275 |
| 305 | 5 MHz | 5 mV/div at BW | X | 100 ns/div | | 283 | $2,590 |
| 221 | 5 MHz | 5 mV/div at BW | X | 100 ns/div | | 284 | $2,260 |
| 213 | 1 MHz | 20 mV/div at BW<br>5 mV/div | | 400 ns/div | | 285 | $2,830 |
| 212 | 500 kHz | 10 mV/div at BW<br>1 mV/div | X | 1 μs/div | | 287 | $2,045 |
| SC 504*1 | 80 MHz | 5 mV/div at BW | X | 5 ns/div | | 382 | $3,895 |
| SC 502*1 | 15 MHz | 5 mV/div at BW<br>1 mV/div | X | 20 ns/div | | 384 | $2,795 |

*1 *The SC 502 and SC 504 are oscilloscopes that must be plugged into a TM 500/TM 5000 mainframe for operation.*
*2 *Programmable via GPIB, useful in Automated Test Applications.*

## STORAGE

When a conventional oscilloscope cannot capture an event and display it for your measurements because the signal is too slow, or too fast and infrequent, or when you need to compare events that happen at different times instead of simultaneously, consider a storage scope. These are obvious applications, but there are many other situations that also call for the unique advantages of storage. Storage can help you:

Observe signal changes during circuit adjustments
Compare new signals with a standard
Increase the brightness of a dim, low-repetition-rate signal for normal viewing
Reduce flicker or noise in a signal
Babysit (unattended monitoring) for a transient event
Capture fast signals that occur infrequently or only once
Capture a complete display of a slowly occurring signal
Enhance other record-keeping techniques like photography

With the right Tektronix storage instrument, the capabilities you need are available, and the storage time can be anywhere from a few minutes to a practically unlimited length of time depending on your choice of instruments.

### Only Tektronix Offers Four Distinct Storage Technologies

Two broad categories of storage instruments are named for the storage medium. CRT storage scopes store the captured waveform when the electron beam writes on a target within the cathode-ray tube. Digital storage scopes quantize the waveform and then store it in a digital memory. In addition, there are waveform digitizers, a very special class of storage instruments available in the Tektronix 7000 Series. Within each category there are different technologies and each has its own set of features and benefits.

### Bistable CRT Storage

The phosphor in a bistable CRT storage scope has two stable states: written and unwritten. Once stored, this phosphor typically allows waveforms to be displayed for several hours, or until erased by the operator. Bistable storage is the easiest CRT storage type to use. It is also the least expensive CRT storage technology. It features bright, long-lasting displays, but in comparison with other storage technologies, bistable storage displays have less contrast.

The advantages of bistable storage make it particularly useful for mechanical measurements, signal comparisons, and data recording.

Split-screen viewing is another advantage of most bistable storage scopes. This feature allows a reference waveform to be stored on one half of the screen while the other half can be used to store the effects of changes made on the circuit. You can also use the split screen to have the reference waveform in the stored mode and the other half of the display in the nonstored mode to monitor an external input.

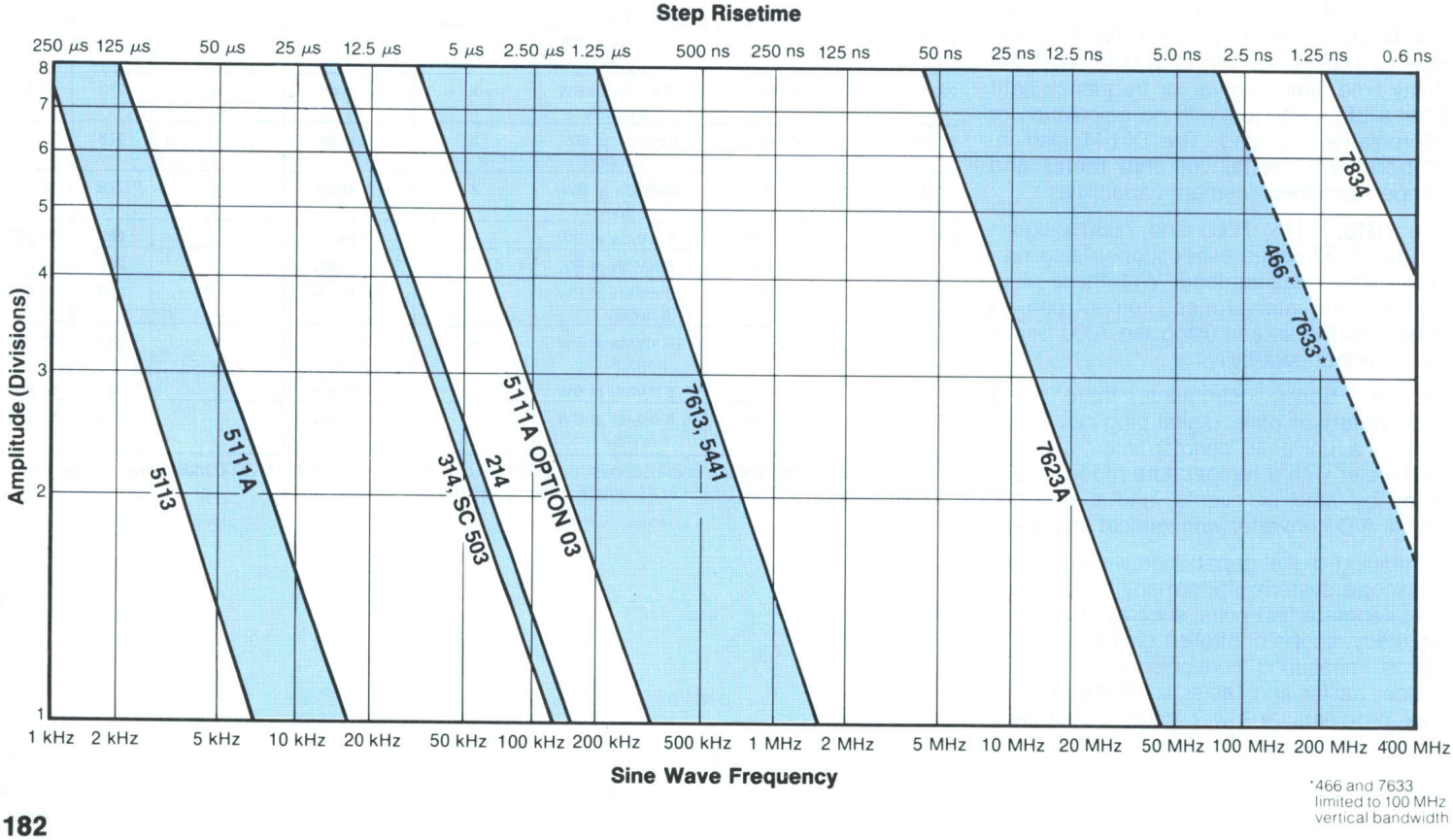
### Variable Persistence CRT Storage

If you don't need to store waveforms for hours at a time, variable-persistence CRT storage has advantages. The variable-persistence storage CRT has a storage mesh where the electron beam writes the input signal; thereafter, flood guns in the CRT illuminate the phosphor where the storage mesh permits.

CRT storage controls vary the charge on the mesh, allowing you to control the contrast between the trace and the background and to fine tune how long the trace is stored.

The first capability provides easy viewing with high constrast between the dark background and bright waveforms. And this type of storage provides the best displays when viewing traces with varying intensities (such as delaying and delayed sweeps, or traces with external z-axis intensity modulation).

## CRT STORAGE PERFORMANCE




*466 and 7633 limited to 100 MHz vertical bandwidth

Varying the persistence permits you to set up the scope so that the entire waveform can be viewed, yet the stored trace will fade from view just as a new waveform is being stored. Or you can view several traces before the first one fades from view. Then you can see signal response variations as you make changes in a circuit.

Variable persistence can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Aberration or jitter not common to all traces will not be stored or displayed. Low repetition rate, fast risetime signals that are not discernible on conventional CRT's can be easily viewed with this storage technology by allowing each repetition to build up the trace brightness.

Applications for variable persistence storage include spectrum analysis, time-domain reflectometry, sampling, and any other measurements that require displays of low-repetition-rate signals.

### Fast Transfer CRT Storage

Fast transfer storage scopes use a CRT with a special intermediate mesh target optimized for speed. This target captures the waveform and then transfers it to another mesh, one optimized for longer-term storage. As the name implies, the fast transfer storage mode provides increased writing speed (see the next heading) for the 466 Portable Oscilloscope and the 7623A, 7633, and 7834 lab scopes.

The second target can also be designed to offer bistable, variable persistence or both modes in combination with the transfer mesh or by itself. In the 7623A, 7633, and 7834, this combination of capabilities provides unique multi-mode storage instruments. Using front panel controls, you can select the operating mode suited to your specific measurement situation.

### Stored Writing Speed

For CRT storage scopes, the storage capability specification is the stored writing speed. This figure of merit is expressed in distance per unit of time. Often div/$\mu$s is more meaningful in terms of your measurements. But because some scopes have nonstandard sized graticules (i.e., other than 1 cm square major divisions) cm/$\mu$s is useful for comparisons.

The specification is dependent on the speed and amplitude of the input signal. If you know the pulse risetime or sinewave frequency of the input signal and the amplitude of the waveform you want to display, you can use the table below to determine which storage scope is recommended.

**CRT STORAGE OSCILLOSCOPES**
**(In Order of Stored Writing Speed)**

| Product | Stored Writing Speed | View Time | Type of Storage | Bandwidth*1 | Minimum Deflection Factor | Number of Traces | Delayed Sweep | Plug-in | Page | Price |
|---|---|---|---|---|---|---|---|---|---|---|
| 7834 | 5500 div/$\mu$s<br>776 div/$\mu$s<br>12 div/$\mu$s<br>0.2 div/$\mu$s | 30 s*3<br>30 min*4 minimum<br>30 s*3<br>30 min*4 minimum | Fast variable persistence<br>Fast bistable<br>Variable persistence<br>Bistable | 400 MHz | 20 mV/div at BW;<br>10 mV/div at 325 MHz | Up to 4 | X | X | 206 | $13,365 |
| 466 | 3000 div/$\mu$s<br>3 div/$\mu$s | 15 s*3<br>15 s*3 | Fast variable persistence<br>Variable persistence | 100 MHz | 5 mV/div at BW | Up to 2 | X | | 288 | $7,560 |
| 7633 | 2200 div/$\mu$s<br>400 div/$\mu$s<br>3 div/$\mu$s<br>0.2 div/$\mu$s | 30 s*3<br>30 min<br>30 s*3<br>30 min minimum | Fast variable persistence<br>Fast bistable minimum<br>Variable persistence<br>Bistable | 100 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>1 mA/div | Up to 4 | X | X | 208 | $8,995 |
| 7623A | 150 div/$\mu$s<br>50 div/$\mu$s<br>0.5 div/$\mu$s<br>0.03 div/$\mu$s | 30 s*3<br>30 min minimum<br>30 s*3<br>30 min minimum | Fast variable persistence<br>Fast bistable<br>Variable persistence<br>Bistable | 100 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>1 mA/div | Up to 4 | X | X | 208 | $6,795 |
| 7613 | 5 div/$\mu$s | 1 hr | Variable persistence | 100 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>1 mA/div | Up to 4 | X | X | 210 | $5,850 |
| 5441 | 5 div/$\mu$s | 1 hr | Variable persistence | 50 MHz | 5 mV/div at BW; 10 $\mu$V/div;<br>0.5 mA/div | Up to 8 | X | X | 241 | $5,245 |
| 5111A Opt 03<br>5111A | 0.8 div/$\mu$s<br>0.05 div/$\mu$s | 10 hr | Bistable split screen | 2 MHz | 1 mV/div at BW; 10 $\mu$V/div;<br>0.5 mA/div | Up to 8 | X | X | 244 | $2,905<br>$2,700 |
| 214 | 0.5 div/$\mu$s | 1 hr | Bistable | 500 kHz | 10 mV/div at BW; 1 mV/div | Up to 2 | | | 292 | $2,795 |
| 314 | 0.4 div/$\mu$s | 4 hr | Bistable | 10 MHz | 2 mV/div at BW | Up to 2 | | | 291 | $4,315 |
| SC 503*2 | 0.08 div/$\mu$s | 4 hr | Bistable | 10 MHz | 1 mV/div at BW | Up to 2 | | | 383 | $4,095 |
| 5113 | 0.02 div/$\mu$s | 10 hr | Bistable split screen | 2 MHz | 1 mV/div at BW; 10 $\mu$V/div;<br>0.5 mA/div | Up to 8<br>dual-beam | X | X | 244 | $4,005 |

**1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*

**2 The SC 503 is an oscilloscope that must be plugged into a TM 500/TM 5000 Mainframe for operation. Please turn to page 383 for more information.*

**3 View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.*

**4 Save intensity at minimum.*

## Digital Storage

The fundamental difference between digital storage scopes and CRT storage scopes is that digital scopes quantize the captured waveform and CRT storage scopes do not. Having quantized waveforms in a digital memory gives you measurement capabilities not possible with any other kind of oscilloscope.

With digital storage scopes, you have the advantage of pretrigger viewing. In other words, you can look at a waveform both before and after the trigger event. Another feature is "babysitting;" available because the digital storage scope's trigger can stop as well as start signal acquisition.

Other digital storage scope advantages include signal processing features such as averaging a number of samples of the input signal to reduce the effects of noise; performing calculations on the waveform parameters; or outputting the signal data over RS-232 or GPIB standard interfaces.

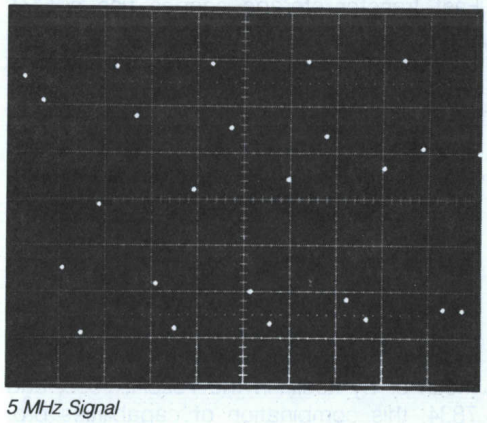
Digital storage scopes are typically easy to use and give you crisp, clear displays. Because the data is stored in a digital memory, no fading or blooming of the trace on the CRT phosphor will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single-shot or low-repetition signals, or where the unique advantages of a digitized waveform may be the answer to your measurement needs.

## Quantization Techniques

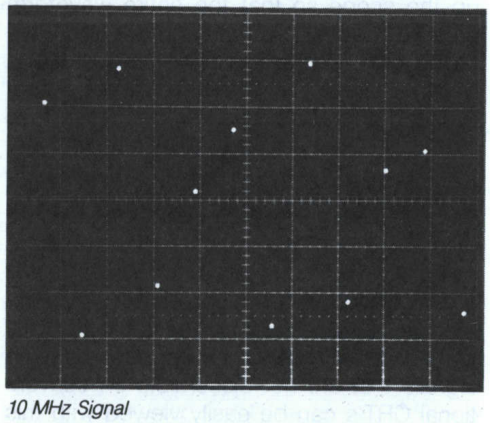
Within digital storage scopes there are two main techniques of quantizing signals—and the technique has a direct effect on the applications of the instruments in that only one kind of digital storage scope can capture single-shot signals.

The digital scopes that can capture signals in a single sweep use what is called "real-time sampling". Other digital storage scopes use "equivalent-time sampling". There are two equivalent-time sampling methods and both require many repetitions of the input signal. In exchange for that requirement, you have the ability to measure signals more than ten times faster than can be captured with real-time sampling.

**With Dot Display**

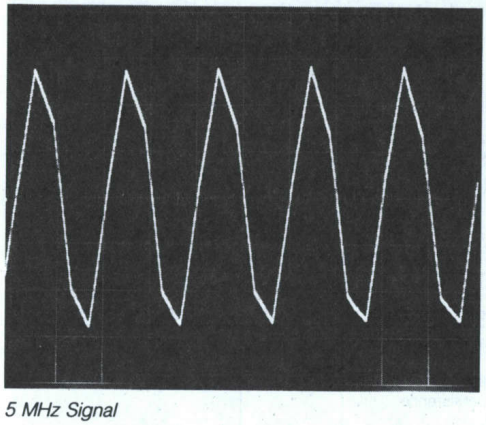


*5 MHz Signal*

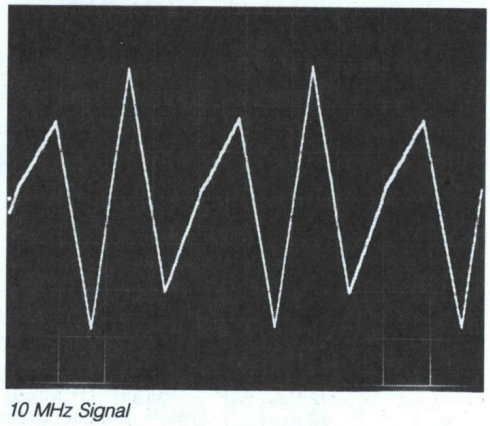


*10 MHz Signal*

**With Pulse Interpolator**

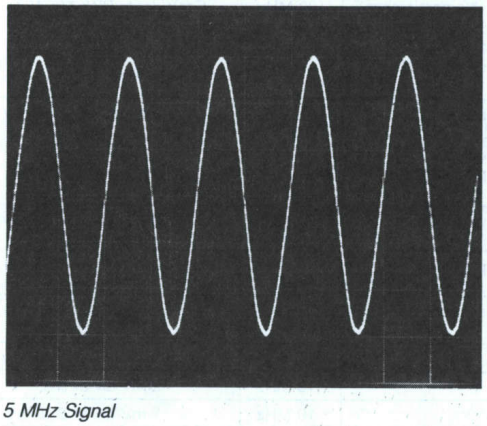


*5 MHz Signal*

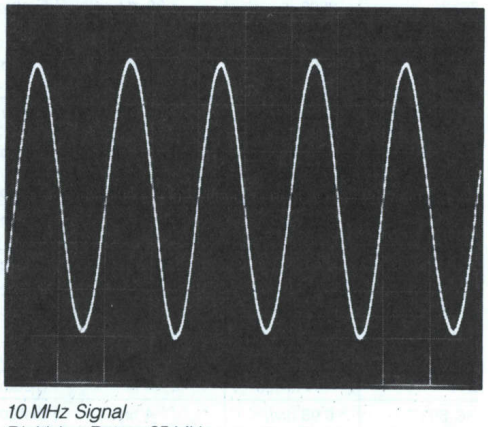


*10 MHz Signal*

**With Sine Interpolator**



*5 MHz Signal*



*10 MHz Signal*
*Digitizing Rate—25 MHz*

### Digital Storage Scope Specifications

For digital storage oscilloscopes that use real time sampling, there is a useful storage bandwidth specification. It expresses the highest frequency sinewave that can be captured in a single sweep and displayed so that you can make measurements. Both the digitizing rate (how often the scope takes samples) and the display reconstruction technique (how the scope displays what's in its memory) must be taken into account in the useful storage bandwidth. See the examples below.

For digital scopes using equivalent time sampling, the specificaton is "equivalent-time bandwidth", the highest frequency signal that can be stored and displayed with less than 3 dB signal amplitude loss. Besides analog specifications (common to all oscilloscopes), other specifications of interest to digital scope users are:

Maximum Digitizing Rate—How often the instrument takes samples of the input signal.

Vertical Resolution (usually expressed in bits of resolution)—How finely the instrument can discriminate between signals very much alike in voltage; for example, 8 bits of resolution is 0.391% when expressed as a percentage, and 10 bits is 0.098%.

Record length or Horizontal Resolution—How many words of digital memory are used to store the captured waveform; if the signal is stored in 512 data words, the horizontal resolution is 1 in 512 or 0.195%.

### Digital Storage Oscilloscope Summary

| | |
|---|---|
| 2220 | Portable Storage Oscilloscope. 60 MHz bandwidth. 100 ns glitch capture (envelope mode), 4 k record length, and save reference memory. |
| 2230 | Portable Storage Oscilloscope. 100 MHz bandwidth. 100 ns glitch capture (envelope mode), 4 k record length, CRT readout, cursor measurements, and save reference memory. |
| 2430 | Portable Storage Oscilloscope. 150 MHz bandwidth. "Save on Delta" feature allows 2430 to make pass/fail decisions. 2 ns Transient capture at any sweep speed. Advanced cursors and readout. |
| 336 | Portable Digital Storage Oscilloscope. Useful storage bandwidth of 140 kHz, microprocessor controlled with features and modes chosen from menu on CRT. |
| 5D10 | Digital Storage Plug-in for the 5000 Series offering real time sampling to 100 kHz, CRT readout, 8-bit vertical resolution, and up to 1024 data words/waveform. |
| 5223 | Digitizing Oscilloscope with 10 bits of vertical resolution, roll mode, X-Y plotter output, and optional GPIB interface. |
| 7D20 | Full GPIB Programmable Waveform Digitizing Plug-in for the 7000 Series. Offers 70 MHz equivalent time bandwidth and capture of transients with frequency components up to 10 MHz. |
| 7854 | Waveform Processing Oscilloscope with 400 MHz equivalent-time bandwidth, keystroke programming, and calibrated sweep speeds to 500 ps/div. |

### Color Digital Storage Oscilloscope

Tektronix' method of producing color oscilloscope displays, Liquid Crystal Display, is described in the technology section. This technology is combined with digital storage in our 5116 Oscilloscope. Full product specifications begin on page 246. Tek's C-59A, C-5C, C-7, or C-4 Cameras can save those color displays on color film. See pages 415-416, 408 for a complete description. A color photography Application Note is available by requesting 52W-5579.

Your local Tektronix sales engineer, representative, or distributor can help you determine the digital oscilloscope parameters necessary to meet your measurement applications needs.

## SAMPLING OSCILLOSCOPES

Sampling is a powerful technique for examining very fast repetitive signals. In principle, sampling is similar to the use of stroboscopic light to study fast mechanical motion. Progressive samples of different portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown (all seemingly at one time) on the screen of a CRT. The display produced is a replica of the sampled waveforms.

Sampling scopes are capable of resolving events that occur in less than 30 ps on an "equivalent" time base of less than 20 ps/div with less than 5 mV of peak amplitude.

If your measurement needs require equivalent bandwidths to 14 GHz or sweeps to 10 ps/div, consider the sampling plug-ins described on page 234.

To determine which instrument fits your requirements, refer to the sampling decision tree on page 230.

This sampling technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal occurs. The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way.

## TEKTRONIX DIGITIZER COMPARISON*1

| | 5223 Digital Oscilloscope | 336 Digital Oscilloscope | 2230/2220 Digital Oscilloscopes | 7854 Waveform Processing Oscilloscope | 7D20/7D20T Programmable Digitizer | 2430 Digital Oscilloscope | 390AD Programmable Digitizer | 7612D Waveform Digitizer | 7912AD Programmable Digitizer |
|---|---|---|---|---|---|---|---|---|---|
| **Digitizing Technique** | Successive approx | Successive approx | Dual parallel conversion | Succesive approx | CCD Successive approx | Successive approx | Dual stage flash conversion | EBS*2 flash conversion | Scan conversion |
| **Maximum Sample Rate** | 1 MS/s (1 μs/point) | 1 MS/s (1μs/point) | 20 MS/s | 500 KS/s (2 μs/point) | 40 MS/s (25 ns/point) | 100 MS/s | 60 MS/s (16.6 ns/point) | 200 MS/s (5 ns/point) | 100 GS/s (10 ps/point) |
| **Vertical Amplifier Analog Bandwidth** | 10 MHz | 50 MHz | 100 MHz (2230) 60 MHz (2220) | 400 MHz/real (14 GHz/samp.) | 70 MHz | 150 MHz | 15 MHz | 80 MHz | 500 MHz/7A29 (200 MHz/7A16P) |
| **Vertical Resolution** | 8 bits | 8 bits | 8 bits | 10 bits | 8 bits | 8 bits | 10 bits | 8 bits | 9 bits |
| **Record Length (Points)** | 254 to 1016 | 1024 per channel | 2048 dual 4096 single | 128 to 1024 | 820 or 1024 per channel | 1024 | 2048 dual 4096 single | 256 to 2048 per channel | 512 |
| **Input Channels** | Up to 4 chopped | 2 chopped | 2 chopped | Up to 4 chopped | 2 | 2 simultaneous acquisition | 2 | 2 | 1 |
| **Independent Time Bases** | 1 plus | 1 plus delaying | 1 plus delaying (2230) 1 (2220) | 1 delaying | 1 plus | 1 plus delaying | 1 plus delaying | 1 | 2 |
| **Maximum Sweep Speed** | 200 ns/div (20 ns in X10) | 100 ns/div (10 ns in X10) | 50 ns/div (5 ns in X10) | 500 ps/div (20 ps/div | 50 ns/div | 5 ns/div | N/A | N/A | 500 ps/div |
| **Pretrigger** | Yes - with 5B25N | pre, mid, post | Yes | Yes - with 7B87 | Yes*3 | Yes | Yes | Yes | delay line only |
| **Posttrigger** | Yes - with delaying | Yes | Yes | Yes - with delaying | Yes | Yes | Yes | Yes | No |
| **Waveform Storage Registers** | 2 to 4 | 2 plus 16 opt | 3 plus 26 opt (2230) 1 (2220) | 2 to 16 (5 to 40 Opt) | 6 | 6 | 2 | 2 to 16 | 1 |
| **Waveform Processing** | | averaging enveloping CH 1 ± CH 2 CH 1 X CH 2, RMS, mean, p-p | averaging smoothing enveloping | averaging parameters keystroke programming | averaging enveloping | averaging envelope save on delta multiply, add | | | averaging |
| **Waveform Data Output Format** | ASCII or binary | binary | ASCII binary hex | ASCII | ASCII or binary | ASCII or binary | binary | binary | binary |
| **Other** | roll mode XY recorder output | XY output cursors CRT readout | roll mode XY recorder output cursors CRT readout cursors (2230) | measurement systems available waveform parameter calculations cursors | roll mode cursors nonvolatile settings | analog plotter output cursors Video Trigger (Opt) direct print out | sample rate switching digital plotter output XY shift mode cursors | sample rate switching measurement systems | measurement systems available |
| **Format Optimization** | operator | operator | operator | operator | systems or operator | systems or operator | systems | systems | systems |
| **Page** | 328 | 313 | 310 | 318 | 315 | 307 | 326 | 321 | 324 |
| **Prices Begin At** | **$5,870** | **$4,960** | **$5,150/$4,150** | **$15,830** | **$7,265/$8,865** | **$8,900** | **$11,400** | **$28,075** | **$27,025** |

**1 For applications not requiring programmability see the 5D10 Waveform Digitizer on page 246.*
**2 Electron Bombarded Silicon.*
**3 The 7D20/7D20T has pretrigger capability in the equivalent time digitizing range for repetitive waveforms as well as for single shot.*

### WAVEFORM DIGITIZERS

Along with conventional oscilloscopes, plug-in or integrated, and with storage oscilloscopes, both digital and analog, Tektronix leads the way in waveform acquisition instruments. This commitment to the future of test and measurement instrumentation can be seen today in three programmable waveform digitizers.

The 390AD Programmable Waveform Digitizer is a dual-channel waveform-acquisition digitizer with a maximum sampling rate of 30 MS/s (or 60 MS/s in single channel operations). Vertical resolution is 10 bits and the memory length is 2048 data words (4096, single channel) with one breakpoint provided to allow changing the digitizing rate during waveform digitizing. More information is available on page 326.

The 7612D Programmable Waveform Digitizer has full dual-channel operations, a maximum sampling rate of 200 MHz, selectable record lengths from 256 to 2048 data words, and the ability to change sampling rates several times during waveform digitizing. See page 321.

The 7912AD Programmable Transient Waveform Digitizer captures waveforms with a scan converter CRT capable of recording 500 MHz single-shot signals. See page 324 for more information if your applications demand equivalent digitizing rates to 100 GHz and 9-bit resolution both vertically and horizontally.

In addition to individual instruments, Tek offers a line of acquisition/processing packages and systems. These preconfigured packages and systems utilize our existing programmable waveform digitzers. See pages 330-337.

# 7000 SERIES INSTRUMENTS

## The 7000 Series . . .

### Superior Performance

The 7000 Series plug-in laboratory instruments embody more state-of-the-art performance features than any other oscilloscope-based measurement system. The 7104 and the R7103 Oscilloscopes feature a 1 GHz bandwidth combined with the fastest risetime and highest photographic writing speed available today.

### Maximum Flexibility

A choice of over 40 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual needs. When your needs change, your present package can be reconfigured with a minimum of additional equipment and effort.

### Expandability

This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Tektronix' most recent developments in plug-in scope capability are: the Waveform Processing Oscilloscope, the 1 GHz High Writing Rate Oscilloscope, the Programmable Digitizer Plug-In Unit, and the four channel Logic Triggered Vertical Amplifier.

### Digital Storage Capability

The 7854 provides digital storage, pre and posttrigger viewing, equivalent time sampling, and waveform processing. The IEEE Standard 488 interface is standard.

## CONTENTS

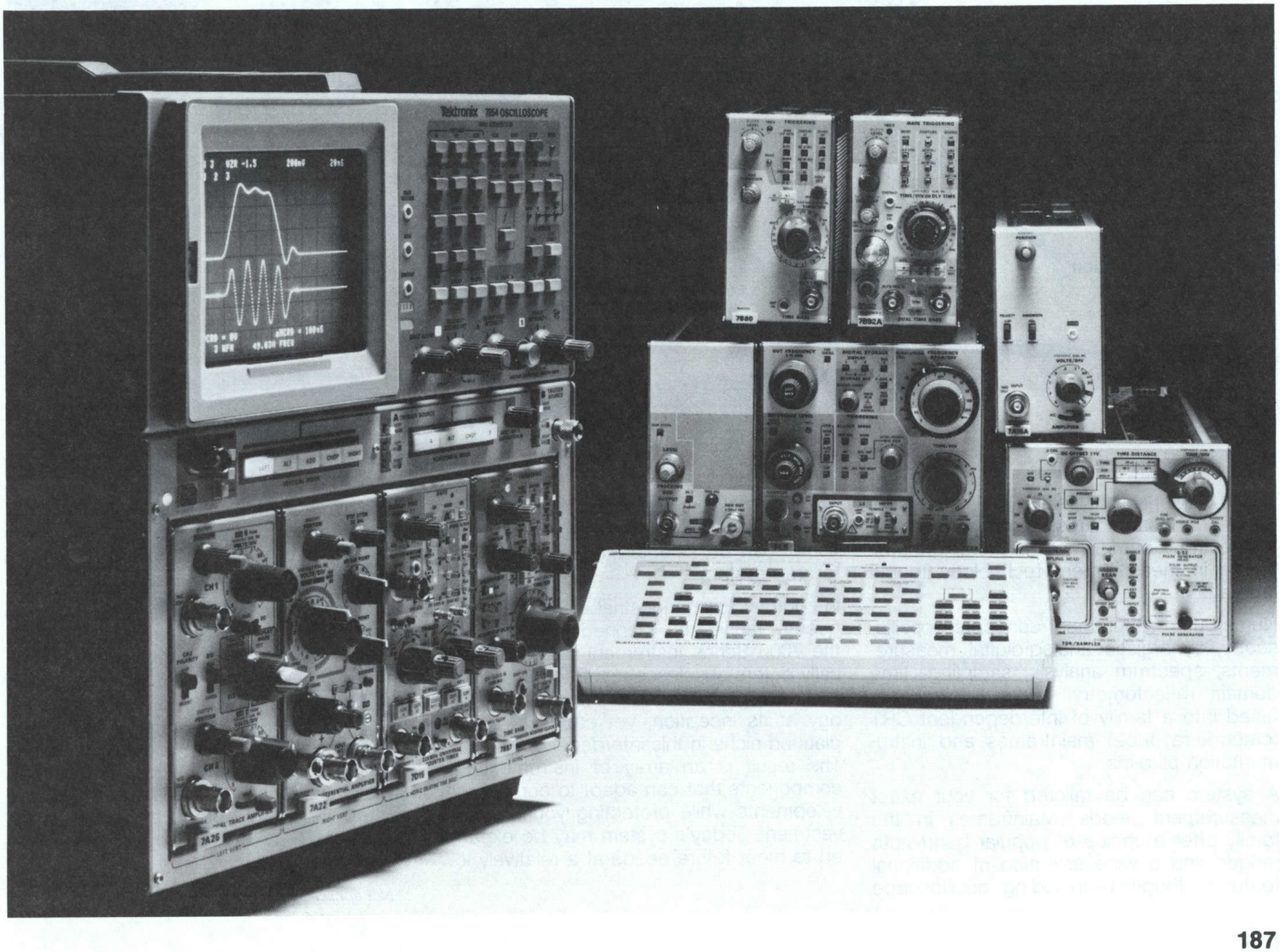

Reference ..... 188

7000 Series
Nonstorage Mainframes ..... 193

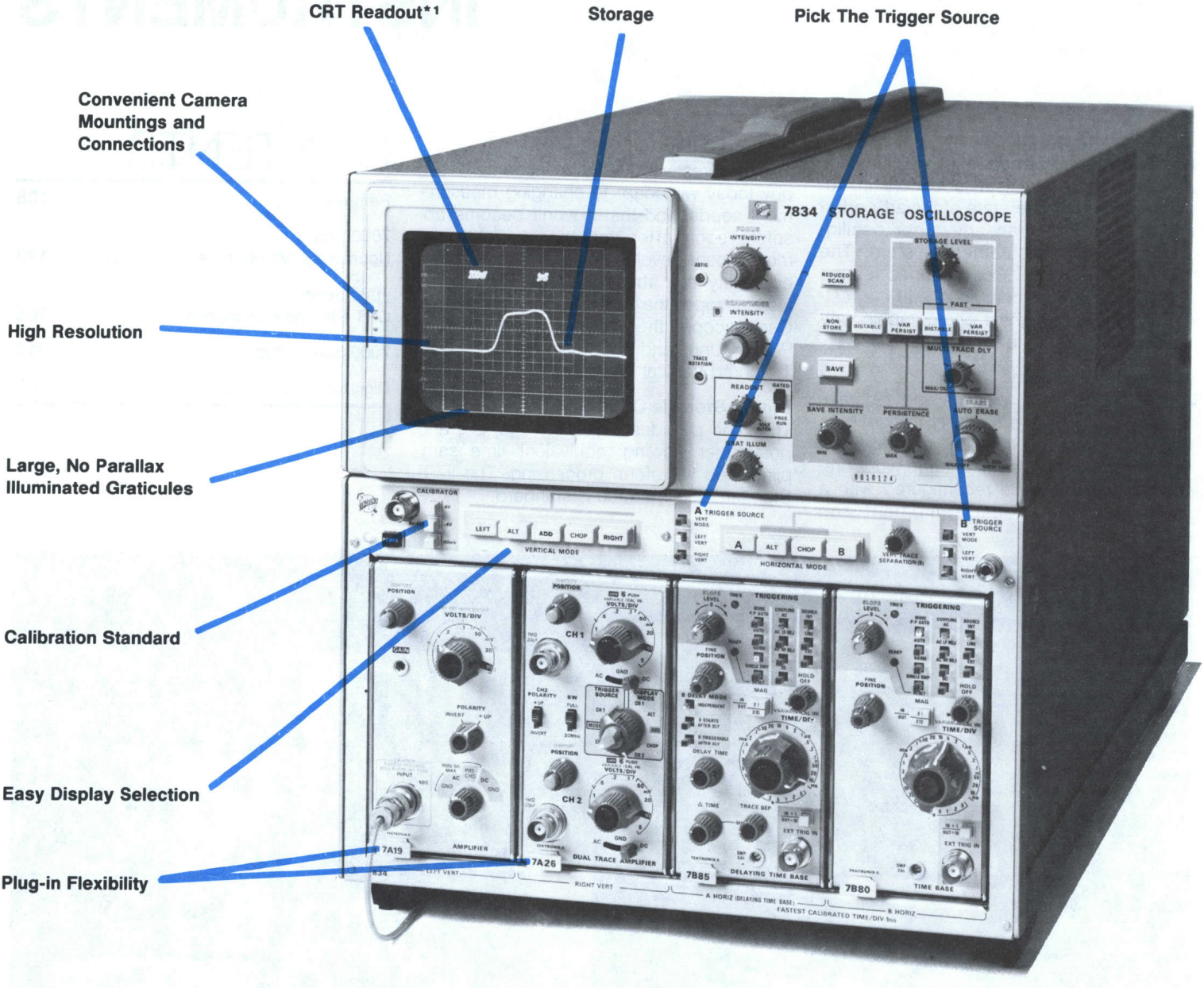
7000 Series
CRT Storage Mainframes ..... 205

7000 Series Plug-ins ..... 212

Digitizers ..... 306

## SUPERIOR PERFORMANCE, FLEXIBILITY AND EXPANDABILITY




The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix commitment to bringing the ultimate in measurement technology to the laboratory.

Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent CRT (cathode-ray-tube) mainframes and instrumentation plug-ins.

A system can be tailored for your exact measurement needs. Mainframes in the family offer a choice of popular bandwidth ranges and a wide selection of additional features. Plug-ins—including oscilloscope vertical amplifiers and time bases as well as instruments for a variety of applications—can be selected to round out your tailored system.

In contrast to an industrial world that is frequently faulted for planned obsolescence, the 7000 Series instrument family strategically defers obsolescence. Each mainframe and each plug-in reflects the latest technology at its inception, yet each fits a well-planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to our new developments while protecting your initial investment. Today's system may be expanded to meet future needs at a relatively low cost by the addition of a plug-in or two. When the time comes to add a more powerful mainframe, your older model continues to be useful for a host of applications.

All significant parameters are displayed in alphanumeric characters right on the CRT. They are readily visible when you need them for quick oscilloscope measurements, and are permanently recorded on your waveform photographs for future analysis and documentation. When your 7000 Series measurement system includes a digital instrument plug-in, the measurement is presented in clear, accurate digital terms, along with a corresponding analog waveform.

*1 *Not applicable for plug-ins with "N" suffix.*

### 400-MHz Dual-Beam

A dual-beam oscilloscope is essentially two oscilloscopes in one. A dual-beam oscilloscope is required in applications where two transient events must be compared simultaneously. These application areas commonly include the observation of simultaneous stimulation and reaction in such fields as medicine, biology, chemistry, and mechanical engineering.

### Digital Measurement Plug-ins

The 7000 Series digital plug-ins include: A universal counter/timer, digital multimeter with temperature measurement capability, digital delay by time or events, and a versatile 0.01% A/D converter with vertical amplifier. Together with a 7000 Series mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital measurements.

### Sampling

The 7000 Series sampling plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: a low-cost storage CRT for slow scans, a random mode that lets you see leading edges without pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional display at the same time on the CRT.

### CRT Storage

Seven 7000 Series mainframes provide some combination of bistable and/or variable persistence storage. The 7834 Storage Oscilloscope can capture single-shot transient events of <2 ns risetime. Variable persistence is valuable for effective viewing of slowly changing events or signals.

### Digital Storage

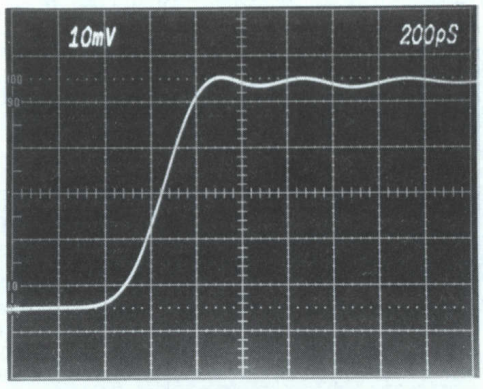
The 7854 Waveform Processing Oscilloscope stores repetitive signals up to 400 MHz with conventional plug-ins, up to 14 GHz with the 7S12 TDR/Sampling plug-in. The 7854 provides digital storage with waveform processing, waveform measurements at the touch of a button, keystroke programming, and a GPIB interface. The 7D20 Programmable Digitizer plug-in provides dual-trace digital storage of signals up to 70 MHz in any 7000 Series mainframe, except the 7104 and R7103.

### Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 2.5 GHz is provided by the 7L5, 7L12 and 7L14 Spectrum Analyzer plug-ins. Stable, sensitive and spurious-free, these analyzers work in any 7000 Series mainframe.

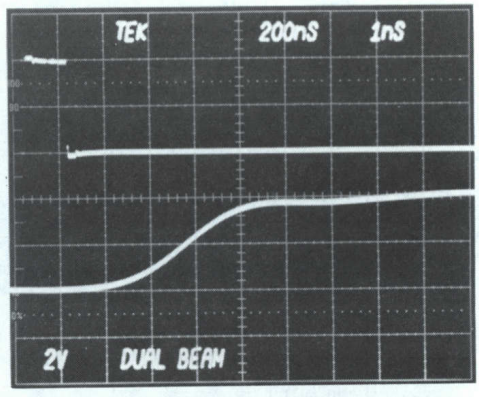
Refer to the Spectrum Analyzer section beginning on page 154 for more information.

## Nonstorage 1 GHz 7104/R7103



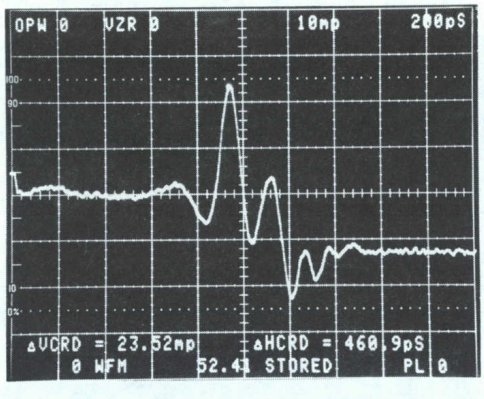

*This 300 ps risetime is displayed on a 7104 Oscilloscope. Readout indicates 10 mV/div vertical sensitivity and 200 ps/div sweep speed. The 7104 and R7103 provide ultra-bright displays which permit the viewing of a single-shot transient event up to the maximum bandwidth of the oscilloscope (1 GHz) in ambient light.*

## Dual Beam 7844/R7844



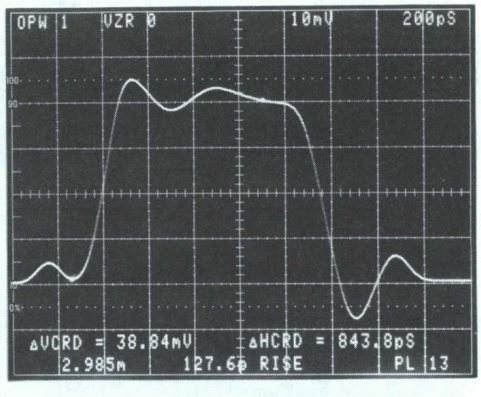

*The 400 MHz 7844 Dual Beam Oscilloscope displays one input signal at two sweep speeds. The 7844 provides full vertical and horizontal crossover switching and full overlap of both vertical amplifiers on its 8 x 10 cm display.*

## Sampling/Time Domain Reflectometry



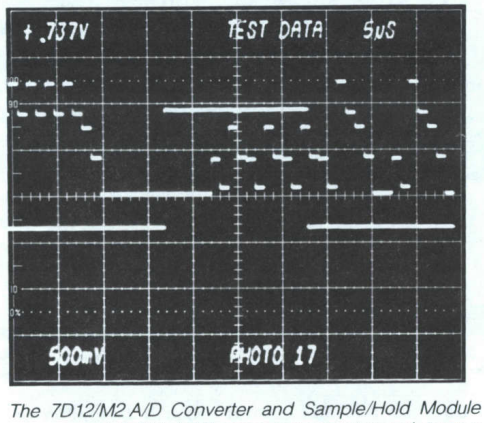

*7854 Waveform Processing Oscilloscope with 7S12 TDR/Sampling plug-in provides time domain reflectometry and digital processing of sampling. In this photo, the 7854/7S12 measures a discontinuity in millirho/division and calculates an impedance of 52.41 Ω at the discontinuity.*

## Digital Storage 7854



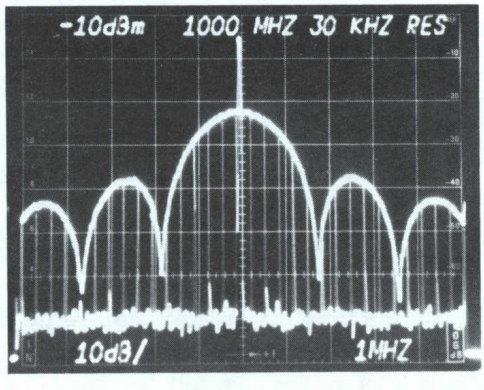

*Here, the 7854 measures the 127.6 ps risetime of a 38.83 mV pulse displayed at a sweep speed of 200 ps/div.*

## Digital Readout Measurements




*The 7D12/M2 A/D Converter and Sample/Hold Module measures +0.737 V difference between two points on a complex waveform. The leading and trailing edges of the gate waveform select the points on the signal to be measured.*

## Spectrum Analysis




*Max Hold feature of the 7L14 Spectrum Analyzer plug-in in a 7000 Series mainframe produces perfectly proportioned Sin x/x spectrum of low rep rate burst of 2.66 MHz, 6.67 μs in width.*

**CRT Storage see page 205.**
**Digitizers see page 306.**

## 7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

| PLUG-IN | | 7A13 | 7A15A | 7A16A | 7A17 | 7A18A | 7A19 | 7A22 | 7A24 | 7A26 | 7A29 | 7A42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Performance Feature | | Differential dc offset, high-freq CMRR amplifier | Low cost conventional input amplifier | Wide bandwidth conventional input amplifier | Low cost, easy to customize amplifier | Dual-channel amplifier | Wide bandwidth 50 Ω input amplifier | Dc-coupled high—gain differential amplifier | Dual-channel 50 Ω amplifier | Dual-channel amplifier | Widest bandwidth single channel | Four-channel logic triggered |
| Minimum Deflection Factor | | 1 mV/div | 5 mV/div (0.5 mV/div)*2 | 5 mV/div | 50 mV/div | 5 mV/div | 10 mV/div | 10 μV/div | 5 mV/div | 5 mV/div | 10 mV/div | 20 mV/div |
| Accuracy*1 Without Probe | | 1.5% | 2% | 2% | — | 2% | 3% | 2% | 2% | 2% | 2% | 3% |
| **7104 R7103** 0 to 35°C | BW | 105 MHz | 80 MHz | 225 MHz | 150 MHz | 100 MHz | 600 MHz | 1 MHz ± 10% | 400 MHz | 200 MHz | 1000 MHz | 350 MHz |
| | Tr | 3.4 ns | 4.4 ns | 1.6 ns | 2.4 ns | 4.7 ns | 0.6 ns | 350 ns ± 9% | 0.9 ns | 1.8 ns | 0.35 ns | 1.0 ns |
| **7904A R7903** 0 to 30°C | BW | 105 MHz | 80 MHz | 225 MHz | 150 MHz | 100 MHz | 500 MHz | 1 MHz ±10% | 350 MHz | 200 MHz | 500 MHz | 300 MHz |
| | Tr | 3.4 ns | 4.4 ns | 1.6 ns | 2.4 ns | 4.7 ns | 0.8 ns | 350 ns ±9% | 1.0 ns | 1.8 ns | 0.7 ns*7 | 1.2 ns |
| | SIG OUT BW | 100 MHz | 70 MHz | 140 MHz | 15 MHz | 90 MHz | 300 MHz | 1 MHz ±9% | 140 MHz | 140 MHz | 300 MHz | NA |
| **7912AD*6** 0 to 30°C | BW | 105 MHz | 80 MHz | 225 MHz | 150 MHz | 100 MHz | 500 MHz | 1 MHz ±10% | 350 MHz | 200 MHz | 500 MHz | 300 MHz |
| | Tr | 3.4 ns | 4.4 ns | 1.6 ns | 2.4 ns | 4.7 ns | 0.8 ns | 350 ns ±9% | 1.0 ns | 1.8 ns | 0.7 ns | 1.2 ns |
| **7844/R** 0 to 35°C | BW | 100 MHz | 80 MHz | 200 MHz | 150 MHz | 100 MHz | 400 MHz*3 | 1 MHz ±10% | 300 MHz | 180 MHz | 400 MHz | 275 MHz |
| | Tr | 3.5 ns | 4.4 ns | 1.8 ns | 2.4 ns | 4.7 ns | 0.9 ns | 350 ns ±9% | 1.2 ns | 1.9 ns | 0.9 ns | 1.3 ns |
| **7854*5 7834** 0 to 35°C | BW | 100 MHz | 80 MHz | 200 MHz | 150 MHz | 100 MHz | 400 MHz*3 | 1 MHz ±10% | 300 MHz | 180 MHz | 400 MHz | 275 MHz |
| | Tr | 3.5 ns | 4.4 ns | 1.8 ns | 2.4 ns | 4.7 ns | 0.9 ns | 350 ns ±9% | 1.2 ns | 1.9 ns | 0.9 ns | 1.3 ns |
| **7704A Opt 09** 0 to 30°C | BW | 100 MHz | 75 MHz | 170 MHz | 150 MHz | 90 MHz | 250 MHz*4 | 1 MHz ±10% | 200 MHz | 170 MHz | 250 MHz | 180 MHz |
| | Tr | 3.6 ns | 4.7 ns | 2.1 ns | 2.4 ns | 4.7 ns | 1.5 ns | 350 ns ±9% | 1.8 ns | 2.1 ns | 1.5 ns | 1.9 ns |
| | SIG OUT BW | 60 MHz | 55 MHz | 70 MHz | 15 MHz | 55 MHz | 80 MHz | 1 MHz ±10% | 70 MHz | 70 MHz | 80 MHz | NA |
| **7704A** 0 to 50°C | BW | 95 MHz | 75 MHz | 160 MHz | 150 MHz | 75 MHz | 250 MHz | 1 MHz ±10% | 200 MHz | 150 MHz | 250 MHz | 175 MHz |
| | Tr | 3.8 ns | 4.7 ns | 2.2 ns | 2.4 ns | 4.7 ns | 1.8 ns | 350 ns ±9% | 1.8 ns | 2.4 ns | 1.8 ns | 2.0 ns |
| | SIG OUT BW | 60 MHz | 55 MHz | 70 MHz | 15 MHz | 55 MHz | 80 MHz | 1 MHz ±10% | 70 MHz | 70 MHz | 80 MHz | NA |
| **7603/R** 0 to 50°C | BW | 75 MHz | 65 MHz | 100 MHz | 100 MHz | 75 MHz | 100 MHz | 1 MHz ±10% | 100 MHz | 100 MHz | 100 MHz | 100 MHz |
| | Tr | 4.8 ns | 5.4 ns | 3.5 ns | 3.5 ns | 4.7 ns | 3.5 ns | 350 ns ±9% | 3.5 ns | 3.5 ns | 3.5 ns | 3.5 ns |
| | SIG OUT BW | 55 MHz | 50 MHz | 60 MHz | 15 MHz | 50 MHz | 65 MHz | 1 MHz ±10% | 60 MHz | 60 MHz | 65 MHz | NA |
| **7633/R 7623A/R 7613/R** 0 to 50°C | BW | 75 MHz | 50 MHz | 100 MHz | 100 MHz | 70 MHz | 100 MHz | 1 MHz ±10% | 100 MHz | 100 MHz | 100 MHz | 100 MHz |
| | Tr | 4.8 ns | 5.4 ns | 3.5 ns | 3.5 ns | 4.7 ns | 3.5 ns | 350 ns ±9% | 3.5 ns | 3.5 ns | 3.5 ns | 3.5 ns |
| | SIG OUT BW | 55 MHz | 50 MHz | 60 MHz | 15 MHz | 50 MHz | 65 MHz | 1 MHz ± 10% | 60 MHz | 60 MHz | 65 MHz | NA |
| **7612D*6** 0 to 40°C | BW | 65 MHz | 60 MHz | 80 MHz | 80 MHz | 65 MHz | 80 MHz | 1 MHz ±10% | 80 MHz | 80 MHz | 80 MHz | 80 MHz |
| | Tr (calculated) | 6.0 ns | 6.7 ns | 5.0 ns | 5.0 ns | 6.0 ns | 5.0 ns | 350 ns ±9% | 5.0 ns | 5.0 ns | 5.0 ns | 5.0 ns |
| **PAGE** | | 218 | 214 | 213 | 214 | 215 | 213 | 219 | 215 | 215 | 213 | 216 |
| **Price** | | **$3,320** | **$695** | **$1,275** | **$455** | **$1,395** | **$2,825** | **$1,745** | **$2,590** | **$2,295** | **$3,245** | **$6,050** |

**1 Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.*

**2 Obtained with 10X gain at reduced bandwidth of 10 MHz.*

**3 Bandwidth is 325 MHz at 10 mV/div.*

**4 Bandwidth is 200 MHz at 10 mV/div.*

**5 Bandwidth with equivalent time sampling and time display only.*

**6 Fully programmable mainframe. 7A16P Programmable Amplifier recommended. See pages 321-325.*

**7 R7903 with 7A29 Tr is 0.8 ns.*

# 7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION GUIDE*1

This selection guide lists the most popular combinations for optimum performance, but is not all inclusive. Current probes and other compatible probes are listed in the Probes Section on page 425.

| | | PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE | | | | | | | | PASSIVE VOLTAGE 50 Ω INPUT COMPAT | | ACTIVE PROBES 50 Ω/1 MΩ INPUT COMPATIBLE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PROBE** | | **P6101A** 1 m | **P6105A** 2 m | **P6130** 1.5 m **P6106A** 1 m | **P6131** 1.3 m | **P6055*2** 3.5 ft | **P6062B*5** 6 ft | **P6009** 9 ft | **P6015** 10 ft | **P6056** 1.5 m | **P6057** 6 ft | **P6201*4** 6 ft | **P6202A*4** 2 m | **P6230*4** 1.5 m | **P6046** 6 ft |
| **FEATURES** | | Miniature | Miniature | Miniature Fast Risetime | Subminiature Fast Risetime | Adj Attenuation Differential | Selectable Attenuation 1X:10X | 1.5 kV Risetime | 40 kV Peak | Fastest 10X Passive Probe Low C | Fastest 100X Passive Probe Low C | Low Capactive Loading Ac Coupling Dc Offset | 10 MΩ Input Impedance Dc Offset | ECL Bias/ Offset | Differential High CMRR |
| **ATTENUATION** | | 1X | 10X | 10X | 10X | 10X | Selectable | 100X | 1000X | 10X | 100X | Selectable | Selectable | 10X | Selectable |
| **7100 FAMILY** | **7A19** | NC | NC | NC | NC | NC | NC | NC | NC | 500 MHz | 480 MHz | 430 MHz | 300 MHz | 480 MHz | 100 MHz |
| | **7A24** | NC | NC | NC | NC | NC | NC | NC | NC | 350 MHz | 350 MHz | 310 MHz | 300 MHz | 350 MHz | 100 MHz |
| | **7A26** | 34 MHz | 100 MHz | 175 MHz | NC | | | 125 MHz | 75 MHz | | | 195 MHz | 185 MHz | 200 MHz | 90 MHz |
| | **7A29** | NC | NC | NC | NC | NC | NC | NC | NC | 950 MHz | 800 MHz | 660 MHz | 450 MHz | 800 MHz | 100 MHz |
| | **7A42** | 34 MHz | 100 MHz | 250 MHz | 300 MHz | | | 130 MHz | 80 MHz | 350 MHz | 350 MHz | 300 MHz | 280 MHz | 350 MHz | 100 MHz |
| **7900 FAMILY** | **7A13** | 34 MHz | 75 MHz | 105 MHz | NC | 65 MHz | | 85 MHz | 65 MHz | | 105 MHz | 105 MHz | 105 MHz | 105 MHz | 70 MHz |
| | **7A15A** | 34 MHz | 75 MHz | 75 MHz | NC | | 75 MHz | 70 MHz | 60 MHz | | 80 MHz | 80 MHz | 75 MHz | 80 MHz | 60 MHz |
| | **7A16A** | 34 MHz | | 200 MHz | NC | | | 130 MHz | 80 MHz | | 205 MHz | 215 MHz | 205 MHz | 205 MHz | 90 MHz |
| | **7A18A** | 34 MHz | 75 MHz | 75 MHz | NC | | 75 MHz | 70 MHz | 60 MHz | | 75 MHz | 75 MHz | 75 MHz | 75 MHz | 60 MHz |
| | **7A19** | NC | NC | NC | NC | NC | NC | NC | NC | 500 MHz | 480 MHz | 430 MHz | 300 MHz | 480 MHz | 95 MHz |
| | **7A22** | 1 MHz | NC | NC | NC | 1 MHz | 1 MHz | | | | | | | | |
| | **7A24** | NC | NC | NC | NC | NC | NC | NC | NC | 350 MHz | 350 MHz | 310 MHz | 290 MHz | 350 MHz | 90 MHz |
| | **7A26** | 34 MHz | 100 MHz | 175 MHz | NC | | | 125 MHz | 75 MHz | | | 185 MHz | 185 MHz | 290 MHz | 85 MHz |
| | **7A42** | 34 MHz | 100 MHz | 250 MHz | 300 MHz | | | 130 MHz | 80 MHz | 300 MHz | 300 MHz | 300 MHz | 300 MHz | 300 MHz | 90 MHz |
| **7800 FAMILY** | **7A13** | 34 MHz | 100 MHz | 100 MHz | NC | 65 MHz | | 85 MHz | 60 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A15A** | 34 MHz | 75 MHz | 75 MHz | NC | | 75 MHz | 70 MHz | 55 MHz | | | 80 MHz | 80 MHz | 80 MHz | 60 MHz |
| | **7A16A** | 34 MHz | 100 MHz | 160 MHz | NC | | | 110 MHz | 75 MHz | | | 165 MHz | 170 MHz | 190 MHz | 85 MHz |
| | **7A18A** | 34 MHz | 85 MHz | 85 MHz | NC | | 85 MHz | 80 MHz | 60 MHz | | | 90 MHz | 75 MHz | 90 MHz | 65 MHz |
| | **7A19** | NC | NC | NC | NC | NC | NC | NC | NC | 400 MHz | 400 MHz | 360 MHz | 320 MHz | 400 MHz | 95 MHz |
| | **7A22** | 1 MHz | 1 MHz | NC | NC | 1 MHz | 1 MHz | 1 MHz | 1 MHz | | | | | | |
| | **7A24** | NC | NC | NC | NC | NC | NC | NC | NC | 300 MHz | 300 MHz | 280 MHz | 270 MHz | 300 MHz | 90 MHz |
| | **7A26** | 34 MHz | 100 MHz | 145 MHz | NC | | | 105 MHz | 75 MHz | | | 155 MHz | 150 MHz | 180 MHz | 85 MHz |
| | **7A42** | 34 MHz | 100 MHz | 200 MHz | 275 MHz | | | 110 MHz | 75 MHz | 275 MHz | 275 MHz | 260 MHz | 260 MHz | 275 MHz | 90 MHz |
| **7704A FAMILY** | **7A13** | 34 MHz | 70 MHz | 95 MHz | NC | 65 MHz | | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A15A** | 34 MHz | 70 MHz | 70 MHz | NC | | 70 MHz | 65 MHz | 55 MHz | | | 75 MHz | 70 MHz | 75 MHz | 55 MHz |
| | **7A16A** | 34 MHz | 100 MHz | 145 MHz | NC | | | 115 MHz | 75 MHz | | | 160 MHz | 150 MHz | 160 MHz | 80 MHz |
| | **7A18A** | 34 MHz | 75 MHz | 75 MHz | NC | | 75 MHz | 70 MHz | 60 MHz | | | 75 MHz | 75 MHz | 75 MHz | 60 MHz |
| | **7A19*3** | NC | NC | NC | NC | NC | NC | NC | NC | 250 MHz | 250 MHz | 220 MHz | 215 MHz | 250 MHz | 85 MHz |
| | **7A22** | 1 MHz | 1 MHz | NC | NC | 1 MHz | 1 MHz | | | | | | | | |
| | **7A24** | NC | NC | NC | NC | | NC | NC | NC | 200 MHz | 200 MHz | 185 MHz | 180 MHz | 200 MHz | 80 MHz |
| | **7A26** | 34 MHz | 100 MHz | 140 MHz | NC | | | 105 MHz | 75 MHz | | | 160 MHz | 140 MHz | 165 MHz | 80 MHz |
| | **7A42** | 34 MHz | 100 MHz | 150 MHz | 180 MHz | | | 115 MHz | 75 MHz | 180 MHz | 180 MHz | 170 MHz | 160 MHz | 180 MHz | 80 MHz |
| **7600 FAMILY** | **7A13** | 34 MHz | 70 MHz | 75 MHz | NC | 55 MHz | 70 MHz | 60 MHz | 55 MHz | | | 75 MHz | 75 MHz | 75 MHz | 55 MHz |
| | **7A15A** | 34 MHz | 60 MHz | 60 MHz | NC | | 60 MHz | 55 MHz | 50 MHz | | | 65 MHz | 65 MHz | 65 MHz | 50 MHz |
| | **7A16A** | 34 MHz | 95 MHz | 95 MHz | NC | | 95 MHz | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A18A** | 34 MHz | 70 MHz | 70 MHz | NC | | 70 MHz | 65 MHz | 55 MHz | | | 75 MHz | 75 MHz | 75 MHz | 55 MHz |
| | **7A22** | 1 MHz | 1 MHz | NC | NC | 1 MHz | 1 MHz | | | | | | | | |
| | **7A26** | 34 MHz | 95 MHz | 95 MHz | NC | | 95 MHz | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |
| | **7A42** | 34 MHz | 95 MHz | 95 MHz | 100 MHz | | 95 MHz | 85 MHz | 65 MHz | | | 100 MHz | 100 MHz | 100 MHz | 70 MHz |

*1 *The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.*

*2 *015-0437-00 Matched pair recommended.*

*3 *Option 09 Mainframe.*

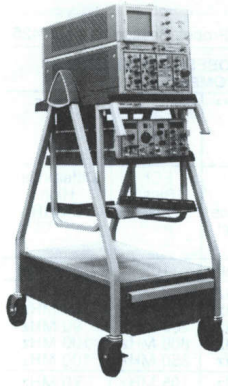
*4 *Requires 1101/1101A Power Supply or other external source of power when used with 7854, 7603, 7633, 7623, or 7613.*

*5 *Bandwidths given for 10X switch position.*
*NC = Not compatible*
*If there is no bandwidth specified, the probe/plug-in combination is compatible but not recommended.*

# 7000 SERIES MAINFRAME/TIME BASE/CAMERA SELECTION GUIDE

| | TIME BASES | | | | | | | | CAMERAS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **7B50A** | **7B53A** | **7B80** | **7B85** | **7B87** | **7B92A** | **7B10** | **7B15** | **C-51** | **C-53** | **C-59** | **C-5C** | **C-7** | **C-4 Opt 02** |
| **Mainframe** | Single Time Base | Dual Time Base with Mixed Sweep | Single Time Base | Single Time Base with Delaying Δ Delay | Single Time Base with Pretrigger | Dual Time Base with Display Switching | Single Time Base | Single Time Base with Delaying Δ Delay | High Writing Rate | General Purpose | | Low Cost | | |
| 7104/R7103 | | | | | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| 7904A/R7903 | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 7844/R7844 | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 7834 | | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| 7854 | | Opt 05*1 | ✓*1 | ✓*1 | ✓ | ✓*1 | ✓*1 | ✓*1 | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 7704A | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ |
| 7603/R7603 | ✓ | ✓ | | | | | | | | | ✓ | ✓ Opt 01 | ✓ Opt 01 | ✓ |
| 7633/R7633<br>7623A/R7623A | ✓ | ✓ | | | | | | | | ✓ | | ✓ | ✓ | ✓ |
| 7613/R7613 | ✓ | ✓ | | | | | | | | ✓ | | ✓ | ✓ | ✓ |
| **Page** | 224 | 224 | 220 | 220 | 220 | 222 | 223 | 223 | 413 | 413 | 415 | 416 | 410 | 408 |
| **Prices Begin At** | **$1,075** | **$1,685** | **$1,620** | **$1,895** | **$1,800** | **$3,745** | **$2,495** | **$2,830** | **$2,360** | **$1,940** | **$1,335** | **$495** | **$595** | **$370** |

*1 *Full capabilities of 7854 not achievable with this time base.*



### TEK C-53 Camera

The full line of cameras designed for 7000 Series oscilloscopes is summarized on the preceding page. For full details see Camera section, page 404.

### K213 Lab Instrument Cart

The K213 Lab Instrument Cart accepts all 7000 Series oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement instruments, 5000 Series oscilloscopes, or 400 Series oscilloscopes. A drawer for the 7854 keyboard and a plug-in storage cabinet are available as Options 10 and 12 respectively, or Option 22 for both. For full details see Cart section, page 422.

## 7000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

| Dimensions | | 7612D | 7912AD | 7854*1 | 7104 | R7103 | 7904A | R7903 | 7844 | R7844 | 7834 | 7704A | 7603 | R7603 | 7633, 7623A, 7613 | R7633, R7623A, R7613 | Plug-ins Single | Plug-ins Double |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Width | mm | 483 | 483 | 305 | 305 | 483 | 305 | 483 | 305 | 305 | 305 | 483 | 221 | 483 | 221 | 483 | 7.1 | 140 |
| | in | 19.0 | 19.0 | 12.0 | 12.0 | 19.0 | 12.0 | 19.0 | 12.0 | 19.0 | 12.0 | 12.0 | 8.7 | 19.0 | 8.7 | 19.0 | 2.8 | 5.5 |
| Height | mm | 178 | 178 | 348 | 345 | 178 | 345 | 135 | 328 | 178 | 345 | 345 | 290 | 133 | 305 | 133 | 127 | 127 |
| | in | 7.0 | 7.0 | 13.7 | 13.6 | 7.0 | 13.6 | 5.3 | 12.9 | 7.0 | 13.6 | 13.6 | 11.4 | 5.3 | 12.0 | 5.3 | 5.0 | 5.0 |
| Depth | mm | 679 | 679 | 627 | 592 | 704 | 577 | 579 | 605 | 630 | 589 | 577 | 610 | 627 | 597 | 566 | 368 | 368 |
| | in | 26.8 | 26.8 | 24.7 | 23.3 | 27.7 | 22.7 | 22.8 | 23.8 | 24.8 | 23.2 | 22.7 | 24.0 | 24.7 | 23.5 | 22.3 | 14.5 | 14.5 |
| **Weights ≈** | | | | | | | | | | | | | | | | | | |
| Net | kg | 25.0 | 22.7 | 20.4 | 19.8 | 20.0 | 16.9 | 12.3 | 16.3 | 15.0 | 16.1 | 13.6 | 13.6 | 13.6 | 13.6 | 14.5 | 0.9 | 4.1 |
| | lb | 55.0 | 50.0 | 45.0 | 43.6 | 44.0 | 37.2 | 27.0 | 36.0 | 33.0 | 35.5 | 30.0 | 30.0 | 30.0 | 30.0 | 32.0 | 2.0 | 9.0 |
| Shipping | kg | 42.1 | 32.6 | 28.1 | 25.4 | 30.9 | 21.4 | 23.6 | 21.3 | 28.5 | 21.3 | 19.5 | 20.8 | 28.2 | 19.0 | 28.2 | 2.3 | 5.4 |
| | lb | 93.0 | 72.0 | 62.0 | 56.0 | 68.0 | 47.0 | 52.0 | 47.0 | 63.0 | 47.0 | 43.0 | 46.0 | 62.0 | 42.0 | 62.0 | 5.0 | 12.0 |

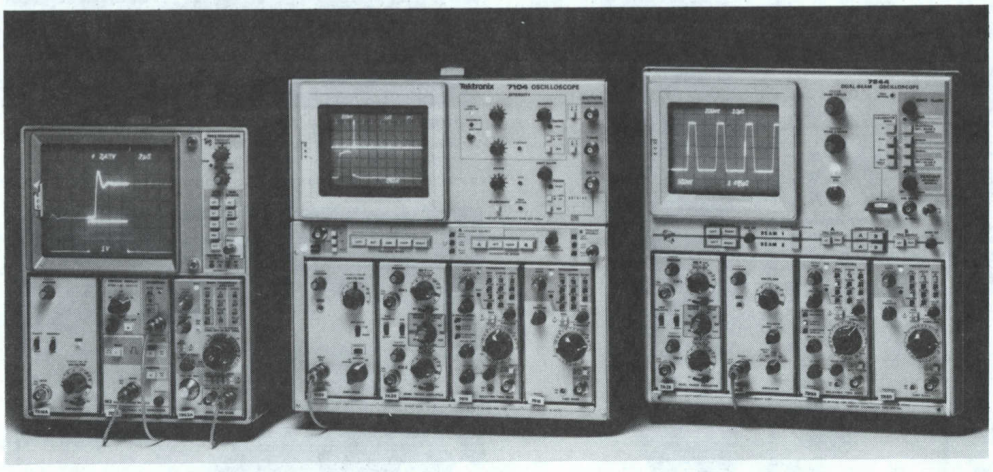
*1 *Calculator dimensions and weights, width 277 mm (10.9 in), height 69 mm (2.7 in), depth 165 mm (6.5 in).*

## CURRENT APPLICATION NOTES FOR 7000 SERIES

| Title | Featuring | Part No |
|---|---|---|
| PULSE ECHO MEASUREMENTS with digital accuracy | 7603/7A22/7D15/7B53A timing measurements between nonadjacent pulses. Ultrasonic transducers. | 42AX-3681-1<br>42W-3681-1 |
| 7A42 | 7A42 Logic triggered amplifier, checking logic levels. | 42W-5629 |
| 7A42 Bus Contention | 7A42 Microprocessor Bus Contention measurements. | 42W-5630 |
| 7A42 Advanced Trigger Application | 7A42 measures complex signals easily. | 42W-5588 |
| X-Y DISPLAYS with Interval Timing for Measuring SOA | 7D15/7A18/7A22 X-Y power dissipation measurements. | 42AX-3957 |
| DAC MEASUREMENTS: The sampling oscilloscope approach | 7S14/7D12/M2/7B92A/7904 measuring DAC (digital analog converter) settling time. | 42AX-3632-1 |
| Accurate Radar Pulse Measurements | 7D11 example of radar pulse delay time measurement | AX-2659-3<br>42W-2659-3 |
| Measuring time interval between non-adjacent digital word train pulses or multiecho radar pulses | 7D15 demonstrates ability to measure the time between adjacent pulses with digital counter accuracy. | 42W-2680-3 |
| The 7D20 Programmable Digitizer: Performing a Wide Range of Measurement Tasks Easier, Faster, and more Accurately | 7D20 application examples including ultrasonic testing, monitoring nerve activity, measuring pulse jitter, and SOA analysis of power devices | 42W-5085 |
| Measuring memory core I/O signals with digital accuracy | 7000 Series digital plug-ins demonstrate how to make accurate pulse parameter measurements both of amplitude and pulse timing. | 42AX-2686-1 |
| Measuring disc drive time and access voltages with Tektronix 7000 Series Digital Plug-ins | 7000 Series digital plug-ins use a single CRT display to perform both digital and analog analysis of complex waveforms. | 42AX-2687-2<br>42W-2687-2 |
| MEASUREMENT VARIETY An Engineering challenge featuring the 7854 | 7854/Waveform Calculator basic operation, application software for percent overshoot, data monitoring and histogram. | 42AX-4281<br>42W-4281-1 |
| GPIB COMMUNICATION with the 7854 | 7854/4052 and 7854/4924 types of I/O transfers, transmissions formats, and operational software in TEK BASIC compatible with any 4050 Series computer. | 42AX-4416-1<br>42W-4416-1 |

| Title | Featuring | Part No |
|---|---|---|
| Pulse and digital timing measurements—a better technique | 7B80/7B85 general operation overview | 42AX-3379-1 |
| Using storage to find troublesome logic glitches | 7633 shows how to capture and evaluate glitches | 42AX-3085 |
| Variable persistence storage applications | 7613/5441 various applications for variable persistence storage oscilloscopes. | 42AX-3198 |
| Automated TDR Testing | Made easy with the 7854 oscilloscope/ 7S12 sampler plug-in. | 42W-5334-1 |
| Bistable storage applications | Tektronix Storage Oscilloscopes. Describes various applications. | 42AX-3199 |
| Increased Measurement Accuracy Using a 7D15 in any 7000 Series Scope | Introduction demonstrating variety of counting & timing measurements. | 42W-5017-1 |
| 7D20 Programmable Digitizer: Digitizing Performance & versatility in a power plug-in | In-depth discussion of the features, functions and capabilities | 42W-5079-1 |
| Sampling for High Speed Measurements | Describes how sampling works, TDR measurements, probes & sampling systems | 42W-5195 |
| Measurement Techniques w/Differential Amplifiers | Outlines what they are, functions & benefits | 42W-5325 |
| Applying Photographic Writing Rate to High Speed Signal Measurements | Describes how scope/camera systems photograph fast moving traces | 42W-5335-1 |
| Power Supply/ Device Testing | Describes advanced 7854 waveform processing functions of typical series of five power supply & device test operations | 42W-5700 |
| Basic SW Programs for Communicating Between 7854 & IBM PC | Describes installation & configuration of National Instrument's IEEE-488 card, & programs to make transfers & specific programs in IBM BASIC | 42W-5802 |
| 7854 Measurement Primer | Teaches most basic functions, including acquiring waveform, stored waveform measurements, storing/displaying multiple waveforms. | 42W-5968 |
| Sampling Primer | Basic sampling principles in signal acquisition for scope measurements. | 42W-5969 |

# 7000 SERIES NONSTORAGE MAINFRAMES



## CONTENTS


7104/R7103 1 GHz General Purpose ..... 194
7904A/R7903 500 MHz General Purpose ..... 197
7844/R7844 400 MHz Dual Beam ..... 203
7704A 200 MHz General Purpose ..... 199
7603/R7603 100 MHz General Purpose ..... 201
Plug-ins ..... 212
High Performance Digitizing Mainframes ..... 306


### 7000 SERIES NONSTORAGE SELECTION GUIDE

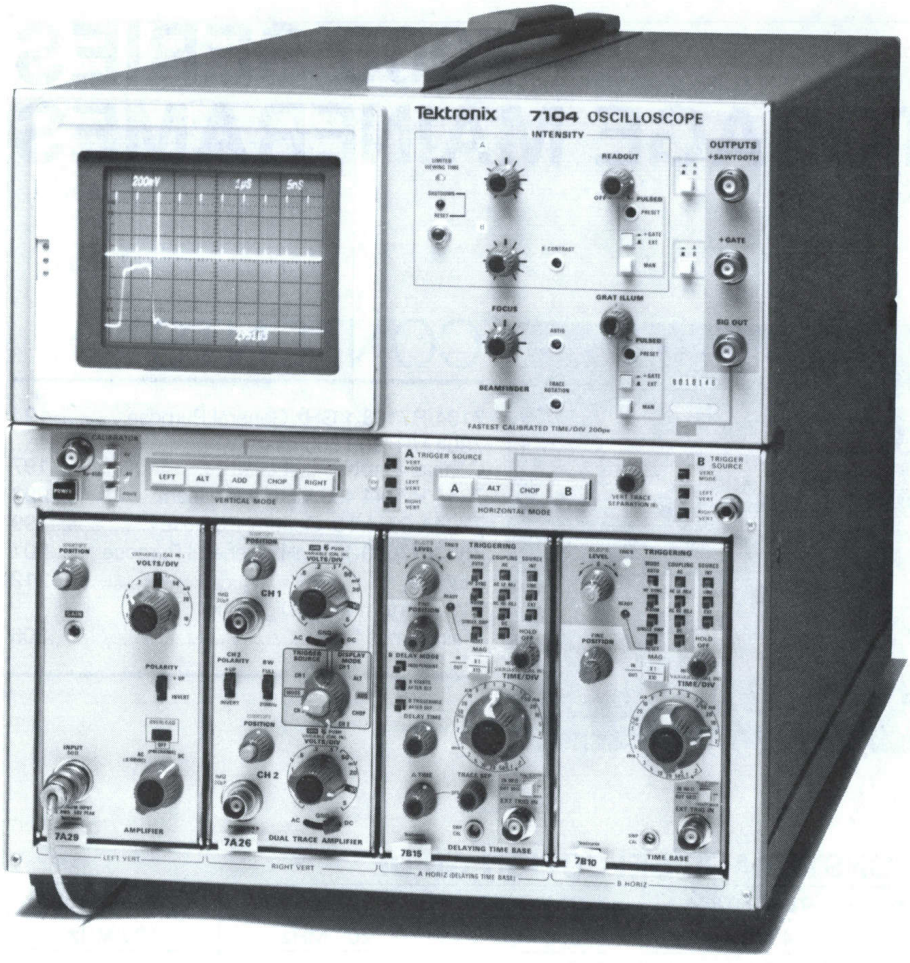
| | 7104/R7103 | 7904A/R7903 | 7844/R7844 | 7704A Opt 09 | 7704A | 7603/R7603 |
|---|---|---|---|---|---|---|
| **Bandwidth*[1]** | 1 GHz | 500 MHz | 400 MHz | 250 MHz | 200 MHz | 100 MHz |
| **Minimum Deflection Factor** | 10 mV/div at BW | 10 mV/div at BW<br>10 μV/div<br>1 mA/div | 20 mV/div at BW<br>10 μV/div<br>1 mA/div | 20 mV/div at BW<br>10 μV/div<br>1 mA/div | 10 mV/div at BW<br>10μV/div<br>1 mA/div | 5 mV/div at BW<br>10μV/div<br>1 mA/div |
| **Maximum Sweep Rate** | 200 ps/div | 500 ps/div | 1 ns/div | 2 ns/div | 2 ns/div | 5 ns/div |
| **Four Traces** | ✔ | ✔ | ✔<br>Dual Beam | ✔ | ✔ | ✔ |
| **Delayed Sweep** | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Page** | 194 | 197 | 203 | 199 | 199 | 201 |
| **Prices*[2] Begin At** | $23,995/$24,520 | $9,635/$9,330 | $14,995/$15,450 | $5,495 | $4,995 | $3,250/$3,720 |

*[1] *Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
*[2] *Price does not include plug-ins.*

A high performance instrument system begins with the basic oscilloscope building block—the 7000 Series mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

The Tektronix 7104 and the R7103 are 1 GHz oscilloscopes featuring the fastest risetime (350 ps) and highest photographic writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, photographic writing speed, dual-beam, alphanumeric displays, rack-mounting, and three- or four-plug-in flexibility.




## 7104/R7103

- 1 GHz at 10 mV/div
- 350 ps Risetime
- 200 ps/div Fastest Calibrated Sweep Rate
- Horizontal Bandwidth 350 MHz
- Ultra High Photographic Writing Speed—at Least 20 cm/ns
- CRT Readout
- 7 Inch Rackmount (R7103 Only)
- Phase Compensation Option—Phase Matching to 250 MHz (7104 Only)

### TYPICAL APPLICATIONS

- * High Speed Semiconductor Design
- * Laser and High Energy Research
- * Digital Communications

See page 192 for available Application Notes.

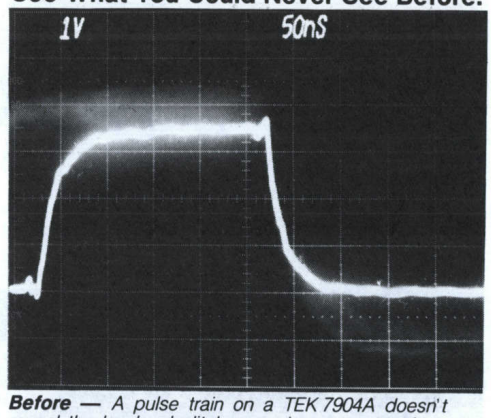
The capabilities of the 7104 and the seven inch rackmount R7103 are of substantial value in numerous high technology environments. The 7104/R7103 have both the highest writing speed and highest bandwidth available in a general-purpose oscilloscope today.

The 7104/R7103's outstanding writing speed means unsurpassed single-shot capability, with trace brightness about **one-thousand** times that of conventional oscilloscopes. Any single-shot signal within the 1 GHz bandwidth can be seen directly on the CRT in average room light. Also, singleshot photography is now simple and straightforward, using standard oscillographic cameras and film without high-speed enhancement techniques.

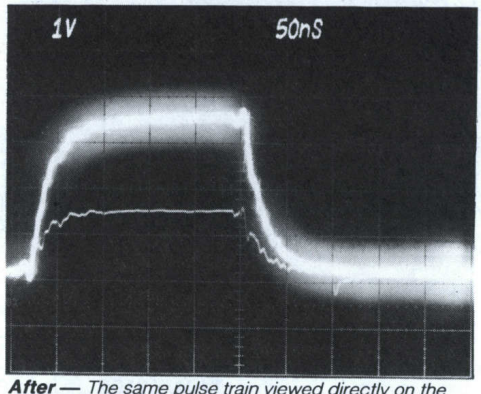
It is by no means unusual to see 250 MHz data rates and 900 MHz analog frequencies outside the lab and on the production line. In digital design, too, anomalies such as ringing and overshoot can only be dealt with by evaluating the signal's analog characteristics.

You can capture the fastest transients without expensive high-speed film or other time consuming and complex techniques like fogging or reducing the scan. In fact, you can see those signals on the CRT, and eliminate costly time consuming photographs.

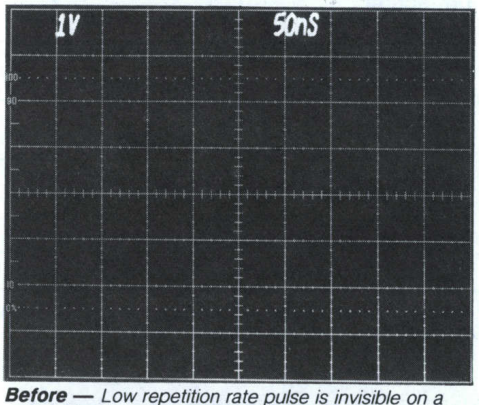
**See What You Could Never See Before.**



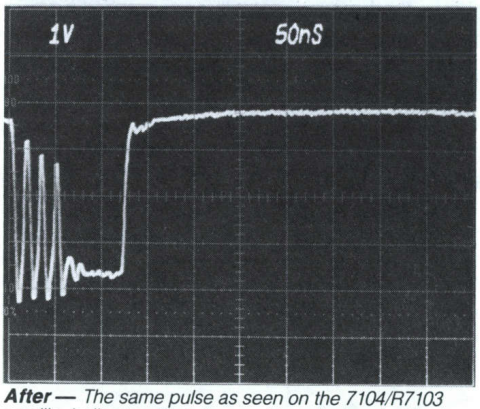

***Before*** *— A pulse train on a TEK 7904A doesn't reveal the low-level glitch occurring every ten-thousandth pulse. (The TEK 7904A was previously the world's fastest-writing-rate scope.)*



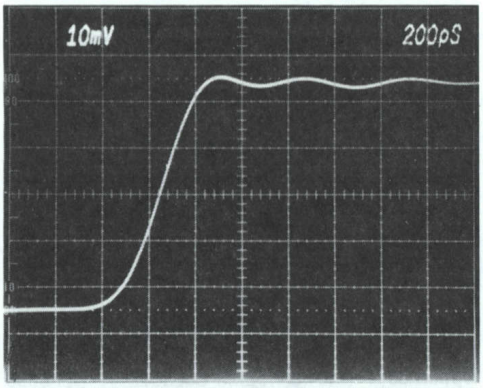

***After*** *— The same pulse train viewed directly on the 7104/R7103, with one-thousand times the brightness of conventional scopes. The researcher can now analyze the pulse with the naked eye and take pictures with ease.*




***Before*** *— Low repetition rate pulse is invisible on a conventional oscilloscope.*




***After*** *— The same pulse as seen on the 7104/R7103 readily indicates that the problem is input signal bounce.*




*With its sweep speed of 200 ps/div, the 7104/R7103 clearly shows a single-shot, 350-ps step, five divisions in amplitude.*

Horizontal bandwidth of 350 MHz, with the X-Y phase compensation Option 02 (7104 only), gives accurate X-Y displays to 250 MHz. Designers can now directly obtain V-I curves for high-speed switching power supply evaluation or monitor performance of digital communication systems using phase constellation displays.

## CHARACTERISTICS

The following characteristics are common to the 7104 and the R7103, except those noted under the R7103.

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins (except 7D01, 7D02, and 7D20).

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Modes** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

**Trace Separation** — (7104 only) In dual sweep modes positions B trace at least four divisions above and below A trace.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments. Compatible with the 7B10 Series, 7B80 Series, 7B50A, 7B92A, 7000 Series vertical amplifiers and specialized plug-ins (7B92, 7D01, 7D02, and 7D20 not recommended).

**Bandwidth** — Dc to 350 MHz.

**Display Modes** — (7104 only) A, Alt, Chop, B. Chopped mode repetition rate is ≈200 kHz.

**Fastest Calibrated Sweep Rate** — 200 ps/div with the 7B10 or 7B15.

**X-Y Mode** — With Delay Compensation (7104 only using 7A19s or 7A29s at least one having Variable Delay Option, B horizontal compartment only): Phase shift is 2° from dc to 50 MHz (after adjusting variable delay for balance at 35 MHz). Phase balance can be obtained at any frequency up to 250 MHz. Without Delay Compensation: Phase shift is 2° from dc to 50 kHz.

### CRT AND DISPLAY FEATURES

For CRT phosphor data see page 181.

**CRT** — Internal 8 x 10 division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV. GH (P31) phosphor standard.

**Readout and Graticule Modes** — Each continuous or pulsed. Pulse Source Front Panel Selectable: +Gate, External, Manual. Pulsed graticule is on for ≈0.5 s.

**Typical Photographic Writing Speed*[1]**

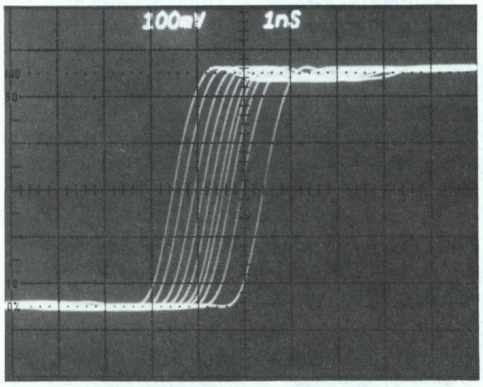
| CRT | Camera | Lens | Writing Speed cm/ns |
|---|---|---|---|
| Standard 8 cm x 10 cm | C-53 | f/1.9 1:0.85 | 20 |

*[1] *Using the standard GH (P31) phosphor standard and Polaroid Type 107, 3,000 ASA film without film fogging.*

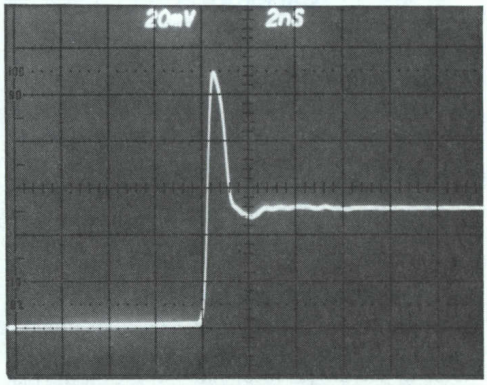
**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating offscreen signal.

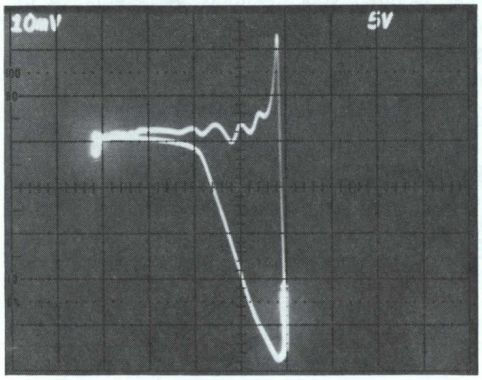
**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.



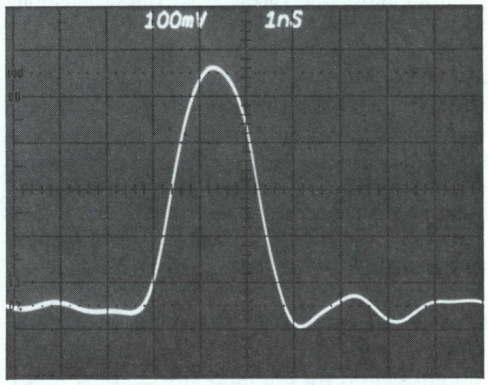

*A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0 ns jitter when viewed with the distinct image viewing capability of the 7104/R7103.*



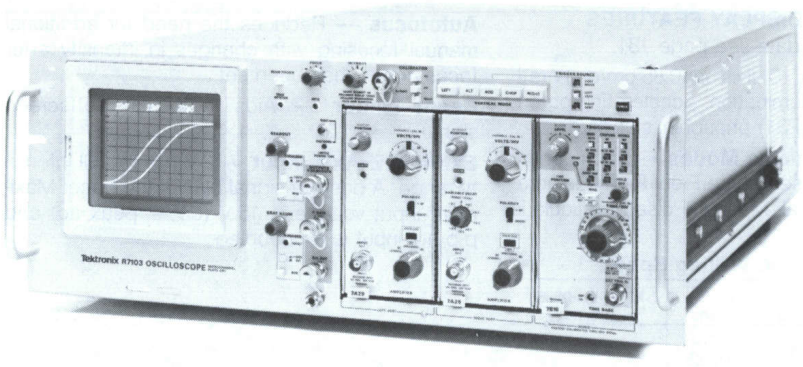

*Circuit faults such as high frequency pulse overshoot and ringing can easily be observed with the 7104/R7103's 1 GHz bandwidth.*




*The transient load line of a fast switching transistor in a power supply prototype (switching time = 10 ns) is easily measured for compliance with safe operating area. (Horizontal = Voltage; Vertical = Current).*




*View of a single clocking pulse 0.8 ns rise and 2 ns pulse width.*




*The R7103 requires only seven inches of rack height in a standard 19 inch rack. It is fan-cooled and comes complete with slideout chassis tracks.*

## CALIBRATOR

**Voltage Output** — Squarewave positive-going from ground.

**Voltage Ranges** — 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%. Repetition rate is 1 kHz within 0.25%.

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

## OUTPUTS/INPUTS

**+Sawtooth** — Starts 1 V or less from ground into 1 MΩ. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**+Gate** — Positive-going rectangular waveform. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

**Vertical Signal Out** — Output voltage is 25 mV/div into 50 Ω, 0.5 V into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See page 190.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series camera.

**Probe Power** — Two rear-panel connectors for active probes (i.e., P6201, P6202A, P6230).

**External Single-Sweep Reset** — Ground closure, rear panel BNC, input to reset sweep.

**Single-Sweep Ready Indicator** — Rear panel BNC provides 5 V out to indicate single-sweep ready condition.

**Graticule/Readout, Single-Shot** — Ground closure, rear panel BNC input initiates one frame of CRT read-out. Graticule Illumination is illuminated for ≈0.5 s.

## POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 215 W, 3.3 A at 90 V line, 60 Hz.

## ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**EMC Capability** — (7104, Option 03 only) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — UL listed (UL1244) and CSA certified (CSA 556B)

## PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 305 | 12.0 | 483 | 19.0 |
| Height | 345 | 13.6 | 178 | 7.0 |
| Depth | 592 | 23.3 | 704 | 27.7 |
| **Weight≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 19.8 | 45.0 | 20.0 | 44.0 |
| Shipping | 25.4 | 56.0 | 30.9 | 68.0 |

# CHARACTERISTICS (R7103)

The following characteristics for the R7103 are in addition to or in lieu of those listed previously.

## HORIZONTAL SYSTEM

**Single Channel** — Right-hand plug-in compartment compatible with time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except 7B50A), the 7B70 Series and the 7B92 (non-A) are not recommended. 7000 Series vertical amplifiers and specialized plug-ins (except 7D01, 7D02, and 7D20) may also be used.

**Bandwidth** — Dc to 350 MHz.

**X-Y Mode** — Phase shift is 2° from dc to 50 kHz.

## OUTPUTS/INPUTS

**Vertical Signal Out** — Output voltage is 25 mV/div within 25% into 50 Ω, 0.5 V into 1 MΩ. Output R is ≈950 Ω.

# ORDERING INFORMATION

## (PLUG-INS NOT INCLUDED)

**7104** Oscilloscope **$23,995**

**Includes:** Power cord (161-0066-00); instruction manual (070-2314-00).

**R7103** Rackmount Oscilloscope **$24,520**

**Includes:** Power cord (161-0066-00); mask frame (426-0514-00); CRT filter (378-0625-00); drawer slide (351-0375-01); right spacer (361-0806-00); left spacer (361-0807-00); hardware kit (016-0099-00); instruction manual (070-0539-00).

### OPTIONS (7104)

**Option 02** — (7104 only) X-Y Horizontal Compensation. **+$315**

**Option 03** — (7104 only) EMC Capability. **+$395**

### CONVERSION KIT (7104)

**EMC Modification** — (7104 only). Order 040-0965-00 **$520**

### INTERNATIONAL POWER PLUG OPTIONS (7104/R7103)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### RECOMMENDED PLUG-INS

**7A29** — Vertical amplifier, 50 Ω input, dc to 1 GHz; 10 mV/div to 1 V/div vertical sensitivity. **$3,245**

**7A42** — Four channel, 350 MHz bandwidth vertical amplifier with Boolean logic triggering capabilities. **$6,050**

**7B10** — Delayed time base with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz. **$2,495**

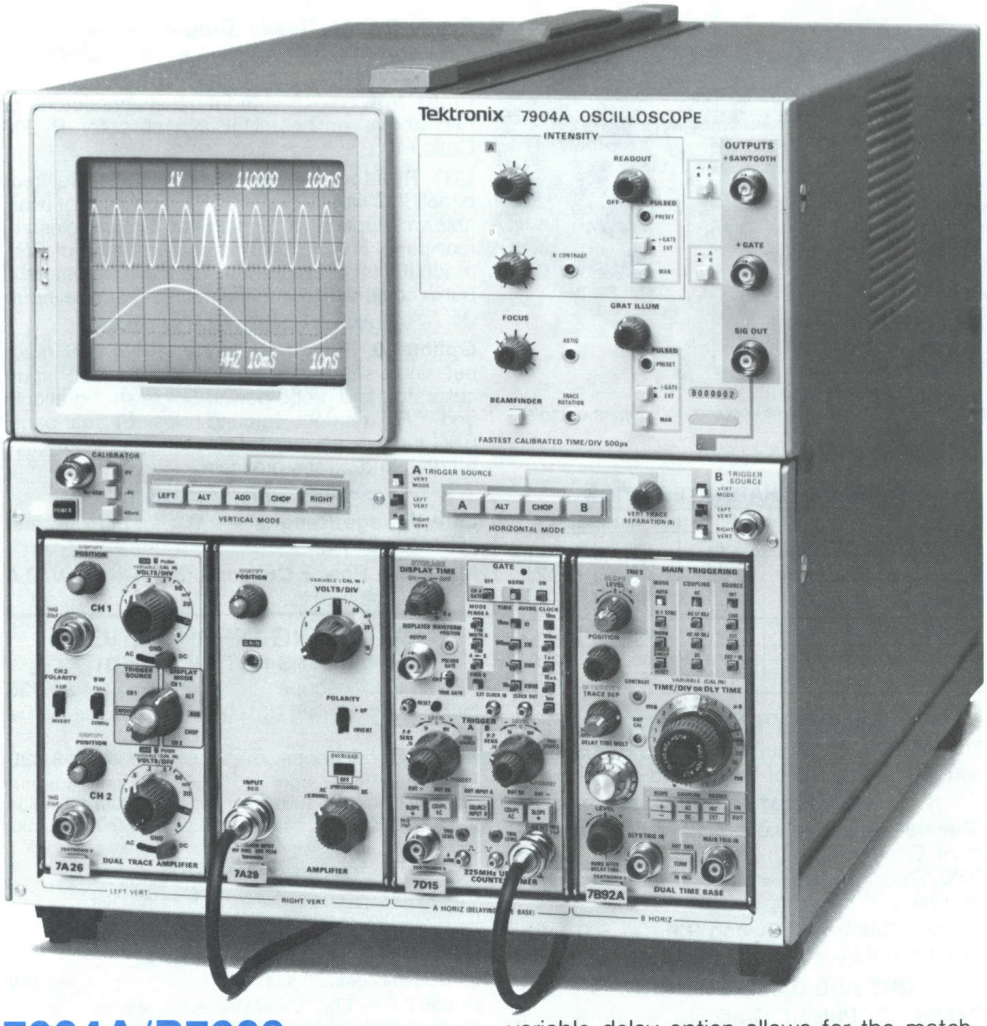
**7B15** — Delaying time base with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz; capable of Δtime measurements in conjunction with 7B10. **$2,830**

**7B92A** — Dual time base with 500 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 500 MHz; capable of delay time measurements. **$3,745**

## OPTIONAL ACCESSORIES

**Recommended Cameras** — See page 406.
**Recommended Probes** — See page 426.
**Recommended Carts** —
K213 Option 12 — (7104) See page 424.
K217 — (R7103) See page 424.

**The 7D01, 7D02 Logic Analyzers and 7D20 Digitizer are not recommended for use in the 7104/R7103 mainframe. Such use will void the 7104/R7103 warranty.**




# 7904A/R7903

**500 MHz at 10 mV/div**

**700 ps Risetime (7904A)**

**500 ps/div Fastest Calibrated Sweep Rate**

**Greater Than 4 cm/ns Writing Speed with Optional CRT (Option 13)**

**CRT Readout**

**Over 30 Compatible Plug-ins**

**900 MHz FET Probe Available**

## TYPICAL APPLICATIONS

- **Digital Design**
- **Radar**
- **Laser Research**

See page 192 for available Application Notes.

The 7904A and 5.25 inch rackmount R7903 are high bandwidth, general-purpose oscilloscopes. The 7A29 Amplifier/7904A mainframe attains 500 MHz at 10 mV/div. A 7A29 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900 MHz bandwidth by itself, and in combination with the 7A29/7904A, it provides a system bandwidth of 450 MHz at 10 mV.

The CRT, the major contributor to the performance of the 7904A and R7903, has good visual brightness and an 8 cm x 10 cm display area.

For high photographic writing speed applications, Option 13 provides BE (P11) phosphor and a reduced scan CRT yielding greater than 4 cm/ns photographic writing rate. For comparison of 7000-Series photographic writing speeds, see page 180.

## CHARACTERISTICS

The following characteristics are common to the 7904A and R7903, except those noted under the R7903.

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Mode** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

**Trace Separation Range** — (7904A only) In dual sweep modes, positions B trace at least four divisions above and below A trace.

**Delay Line** — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. 7B50 Series not recommended.

### HORIZONTAL SYSTEM

**Channels** — 7904A: Two right-hand plug-in compartments. R7903: One right-hand plug-in compartment. 7904A and R7903: Compatible with 7B80 and 7B90 Series time bases, 7000 Series vertical amplifiers and specialized plug-ins.

**Bandwidth** — Dc to at least 1 MHz.

**Display Modes** — A, Alt, Chop, B. Chopped mode repetition rate is ≈200 kHz.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B92A.

**X-Y Mode** — With Delay Compensation: Phase shift is within 2° from dc to 1 MHz. Without Delay Compensation: Phase shift is within 2° from dc to 35 kHz.

### CRT AND DISPLAY FEATURES

For CRT phosphor data see page 180.

**CRT** — Internal 8 x 10 division (0.85 cm/div) graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

**Option 04, Maximum Brightness CRT with Reduced Area** — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

**Option 13, Maximum Brightness CRT with Reduced Area** — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with BE (P11) phosphor.

**Option 78, BE (P11) Phosphor** — Replaces standard GH (P31) phosphor.

**Typical Photographic Writing Speed*1**

| CRT | Camera | Lens | Writing Speed cm/ns |
|---|---|---|---|
| Opt 13 4 cm x 5 cm | C-51P | f/1.2 | 4 |
| Opt 78 8 cm x 10 cm | | 1:0.5 | 2.5 |

*1 *Using the optional BE (P11) phosphor and Polaroid Type 612 20,000 ASA Film without film fogging.*

In typical applications, GH (P31) phosphor standard has approximately one-half the writing speed of BE (P11) phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory). See page 405.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating offscreen signal.

**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

### CALIBRATOR

**Output Waveshape** — Rectangular positive-going from ground.

**Voltage Ranges** — 40 mV, 0.4 V, 4 V into an open circuit. 4 mV, 40 mV, 0.4 V into 50 Ω. Amplitude accuracy is within 1%. Repetition rate is 1 kHz within 0.25%.

**Current Output** — 40 mA with optional current loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

*The R7903 requires only 5.25 inches of rack height in a standard 19 inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.*

### OUTPUTS/INPUTS

**+Sawtooth —** Sawtooth starts 1 V or less from ground into 1 MΩ. Front-panel selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**+GATE —** Positive-going rectangular waveform derived from A, B, or Delayed Gate, front-panel selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω.

**Vertical Signal Out —** Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See page 192.

**Camera Power —** Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

**Probe Power —** Two rear-panel connectors for two active probes.

### POWER REQUIREMENTS

**Line Voltage Ranges —** 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency —** 48 Hz to 440 Hz.

**Maximum Power Consumption —** 210 W, 3.5 A at 90 V line, 60 Hz.

### ENVIRONMENTAL AND SAFETY

**Ambient Temperature —** Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude —** Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration —** Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Humidity —** Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock —** Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**EMC Capability —** Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety —** UL listed (UL 1244) and CSA certified (CSA 556B).

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 305 | 12.0 | 483 | 19.0 |
| Height | 345 | 13.6 | 135 | 5.3 |
| Depth | 577 | 22.7 | 579 | 22.8 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 16.9 | 37.2 | 12.3 | 27.0 |
| Shipping | 21.4 | 47.0 | 23.6 | 52.0 |

## CHARACTERISTICS (R7903)

The following characteristics for the R7903 are in addition to or in lieu of those listed previously.

### HORIZONTAL SYSTEM

**Channel —** Single right-hand plug-in compartment. Compatible with 7B80 Series, 7B90 Series, 7000 Series vertical amplifiers and specialized plug-ins.

**Fastest Calibrated Sweep Rate —** 500 ps/div with the 7B92A.

### CRT AND DISPLAY FEATURES

**Option 10, Pulsed Graticule —** Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with CRT readout, Option 10 provides additional controls and inputs for CRT readout pulsed operation.

### CALIBRATOR (NOT AVAILABLE WITH OPTION 10)

**Voltage Ranges —** 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω.

**Current Output —** 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

### OUTPUTS/INPUTS (STANDARD)

**+Sawtooth —** Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**+Gate —** Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime is 7 ns or less into 50 Ω. Output R is ≈950 Ω.

**Vertical Signal Out —** Selected by Trigger Source switches. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in. See page 190.

**External Single-Sweep Reset —** Ground closure, rear panel input to reset sweep.

**Single-Sweep Ready Output —** Rear panel BNC provides 5 V out to indicate single-sweep ready condition.

**Probe Power —** Two front-panel connectors for two active probes. Not available for R7903 Option 10.

**CRT Readout —** Inhibit: Ground closure, rear panel BNC input locks out CRT readout. Not available with Option 10. Single-Shot: Ground closure, rear panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

### OUTPUTS/INPUTS (OPTIONS)

**Option 10, Pulsed Graticule —** No CRT readout single-shot input, CRT readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear-panel BNC input is added. Initiates one frame of CRT readout and pulses graticule.

### POWER REQUIREMENTS

**Line Voltage Ranges —** 90 V to 132 V ac and 180 V to 264 V ac.

**Maximum Power Consumption —** 160 W, 2 A at 115 V line, 60 Hz.

## ORDERING INFORMATION (PLUG-INS NOT INCLUDED)

**7904A** Oscilloscope **$9,635**

**Includes:** Power cord (161-0066-00); instruction manual (070-4593-00).

**R7903** Oscilloscope **$9,330**

**Includes:** Power cord (161-0066-00); test adaptor (012-0092-00); two 18 in test leads (012-0087-00); slide guide (351-0314-01); hardware kit (016-0099-00); instruction manual (070-1464-00).

### OPTIONS (7904A/R7903)

**Option 02 —** (7904A only) X-Y Horizontal Compensation. Adds an X-Y delay compensation network that equalizes the signal delay between either vertical compartment and the B horizontal compartment. **+$260**

**Option 03 —** EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

**Option 04 —** (R7903 only) Maximum Brightness 4 cm x 5 cm CRT Display. GH (P31) Phosphor is Standard. **+$500**

**Option 10 —** (R7903 only) Pulsed Graticule. **+$260**

**Option 13 —** Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor. **+$600**

**Option 78 —** BE (P11) Phosphor. **+$100**

### CONVERSION KITS (7904A/R7903)

**X-Y Horizontal Compensation —**
(7904A only). Order 040-0606-00 **$390**

**EMC Capability —**
(7904A) Order 040-0570-00 **$375**
(R7903) Order 040-0647-00 **$375**

**CRT Readout —**
(R7903 only) Order 040-0605-03 **$650**

### INTERNATIONAL POWER PLUG OPTIONS (7904A/R7903)

**Option A1 —** Universal Euro 220 V/16 A, 50 Hz.
**Option A2 —** UK 240 V/13 A, 50 Hz.
**Option A3 —** Australian 240 V/10 A, 50 Hz.
**Option A4 —** North American 240 V/15 A, 60 Hz.
**Option A5 —** Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES (7904/R7903)

**Recommended Plug-ins —** See page 190.
**Recommended Probes —** See pages 191 and 426.
**Recommended Cameras —** See pages 192 and 406.
**Recommended Carts —**
K213 Option 12 — (7904A) See page 424.
K217 — (R7903) See page 424.

**Tektronix offers service training classes on the 7904A General Purpose Oscilloscope. For further training information, contact your local sales/service office or request a copy of the Customer Service Training Catalog on the return card in the back of this catalog.**

# 7704A

**Dc to 250 MHz Bandwidth (Option 09)**

**Dc to 200 MHz with Optimum Pulse Response**

**1.8 ns Risetime**

**2 ns/div Fastest Calibrated Sweep Rate**

**Greater Than 15 cm/ns Enhanced Writing Speed with Optional CRT Option 13 and WSEN**

**CRT Readout**

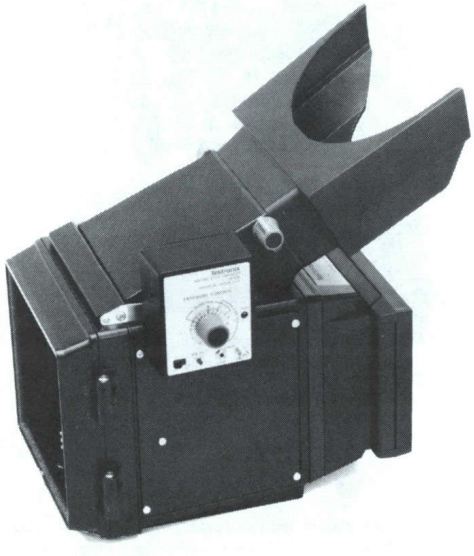
## TYPICAL APPLICATIONS

* **Communications**
* **Digital Design**
* **Component Testing**

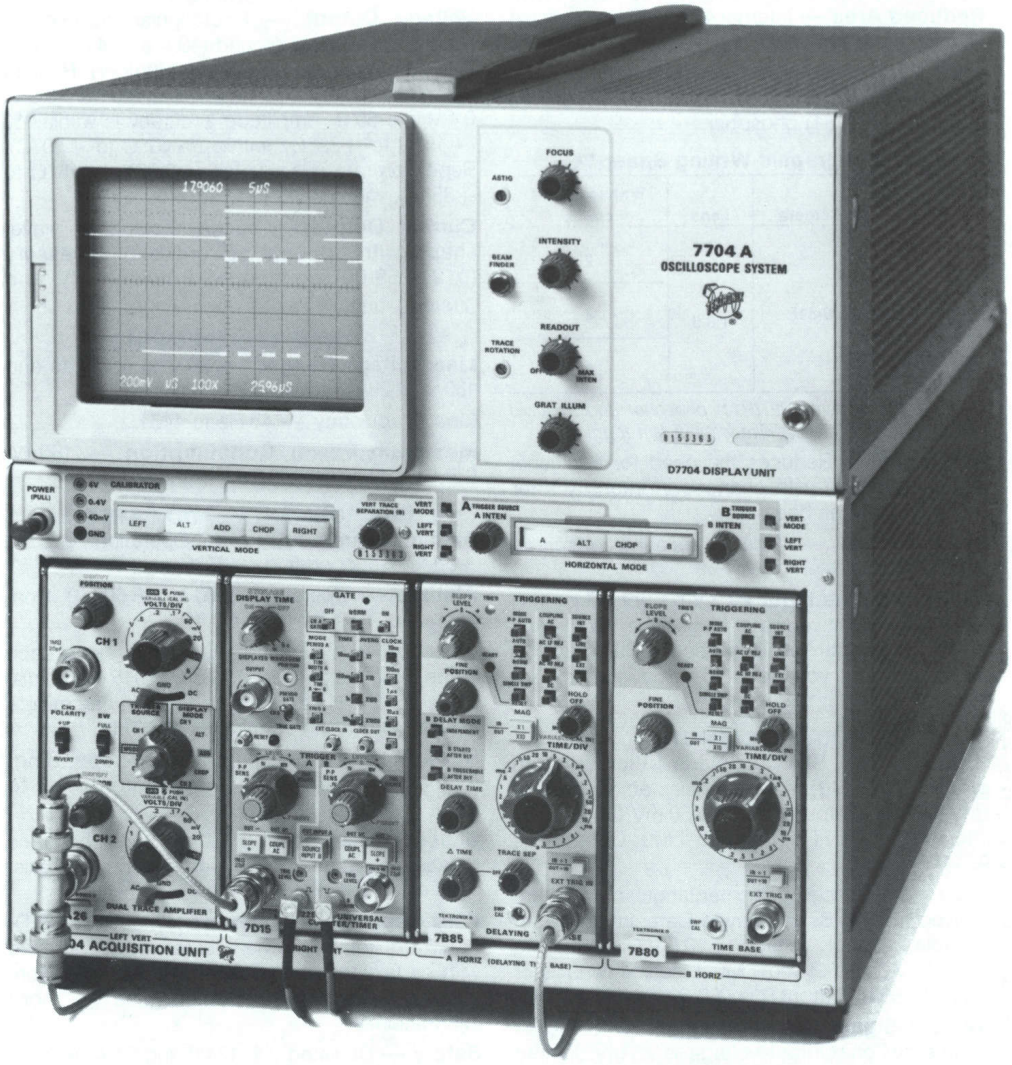
See page 192 for available Application Notes.

The 7704A offers you a choice of bandwidth performances to optimize the oscilloscope for your type of application. In the standard model, pulse aberrations are minimized while giving you a bandwidth of 200 MHz. For higher frequency applications, Option 09 provides a bandwidth of 250 MHz.

For high writing speed applications, Option 13 provides BE (P11) phosphor and a reduced scan CRT yielding >15 cm/ns photographic writing rate with the Tektronix C-51 Camera and WSEN (writing speed enhancer described on page 405). For a comparison of 7000-Series photographic writing speeds see page 180.



*C-51P Camera shown with WSEN.*




## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Option 09, Bandwidth Change (250 MHz)** — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper −3 dB) when 7A29 is used. Provides additional performance for those working in this frequency domain.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Modes** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is internally selectable ≈100 kHz or 1 MHz.

**Trace Separation** — In dual sweep modes, positions B trace above and below A trace.

**Delay Line** — Permits viewing leading edge of waveform.

### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 2 ns/div.

**Chopped Mode (Between Horizontal Plug-ins)** — Repetition rate is internally selectable, ≈20 kHz or 200 kHz.

**X-Y Mode** — Phase shift is within 2° from dc to 50 kHz between vertical and horizontal channels. Frequency response: <10% down at 3 MHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

**Option 04, Maximum Brightness CRT with Reduced Area** — Internal 4 cm x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. GH (P31) phosphor is standard.

**Option 13, Maximum Brightness CRT with Reduced Area** — Internal 4 cm x 5 cm graticule with BE (P11) phosphor. Accelerating potential is 24 kV.

**Option 78, BE (P11) Phosphor** — Replaces standard GH (P31) phosphor.

**Typical Photographic Writing Speed*[1]**

| CRT | Camera | Lens | Writing Speed cm/ns |
|---|---|---|---|
| Opt 78 8 cm x 10 cm | C-51P | f/1.2 1:0.5 | 2 |
| Opt 13 4 cm x 5 cm | | | 4 |
| Opt 04 4 cm x 5 cm | | | 2 |

*[1] *Using the optional BE (P11) phosphor and Polaroid Type 612 20,000 ASA Film without film fogging.*

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating offscreen signal.

**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Minimum pulse width to blank trace is 30 ns at 2 V. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

## OUTPUTS/INPUTS

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω nominal.

**+Gate** — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω. Output R is 950 Ω nominal.

**Vertical Signal Out** — Selected by B Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. The bandwidth depends upon vertical plug-in. Output R is 950 Ω nominal.

**External Single-Sweep Reset** — Ground closure, rear-panel input to reset sweep.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes.

## CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is 1 kHz within 0.25% (+15°C to +35°C); within 0.5% (0°C to +50°C).

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

## POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 264 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 180 W, 2.5 A at 115 V line, 60 Hz.

## ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**EMC Capability** — (Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 305 | 12.0 |
| Height | 345 | 13.6 |
| Depth | 577 | 22.7 |
| **Weights ≈** | **kg** | **lb** |
| Net | 13.6 | 30.0 |
| Shipping | 19.5 | 43.0 |

## ORDERING INFORMATION
### (PLUG-INS NOT INCLUDED)

**7704A** Oscilloscope **$4,995**

**Includes:** 20 in two-pin-to-BNC cable (175-1178-00); instruction manual (070-0981-00).

### OPTIONS

**Option 03** — EMC Capability. **+$395**

**Option 04** — Maximum Brightness 4 cm x 5 cm CRT Display. GH (P31) Phosphor is Standard. **+$500**

**Option 09** — Bandwidth Change to 250 MHz. **+$500**

**Option 13** — Maximum Brightness 4 cm x 5 cm CRT Display with BE (P11) Phosphor. **+$600**

**Option 78** — BE (P11) Phosphor. **+$100**

### CONVERSION KITS

**CRT Readout** — With Probe Power. Order 040-0613-06 **$700**

**EMC Capability** — Order 040-0612-00 **$375**

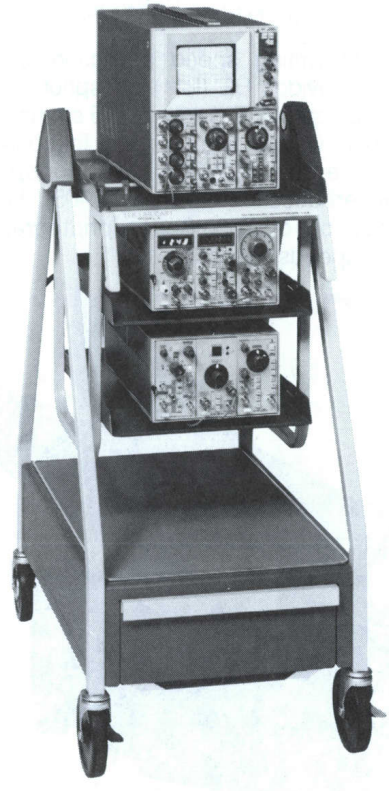
**Signal Out/In** — Order 040-0619-03 **$200**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES

**Recommended Plug-ins** — See page 190.
**Recommended Probes** — See pages 191 and 426.
**Recommended Cameras** — See pages 192 and 406.
**Recommended Cart** — K213 Option 12 — See page 424.



*The K213 cart shown with optional plug-in storage and keyboard drawer.*

**Tektronix offers service training classes on the 7704A General Purpose Oscilloscope. For further training information, contact your local sales/service office or request a copy of the Customer Service training Catalog on the return card in the back of this catalog.**

# 7603/R7603

**Dc to 100 MHz Bandwidth**

**3.5 ns Risetime**

**5 ns/division Fastest Calibrated Sweep Rate**

**Greater than 260 cm/μs Writing Speed with Optional CRT (Option 13)**

**6.5 Inch CRT**

**CRT Readout**

**5.25 Inch Rackmount**

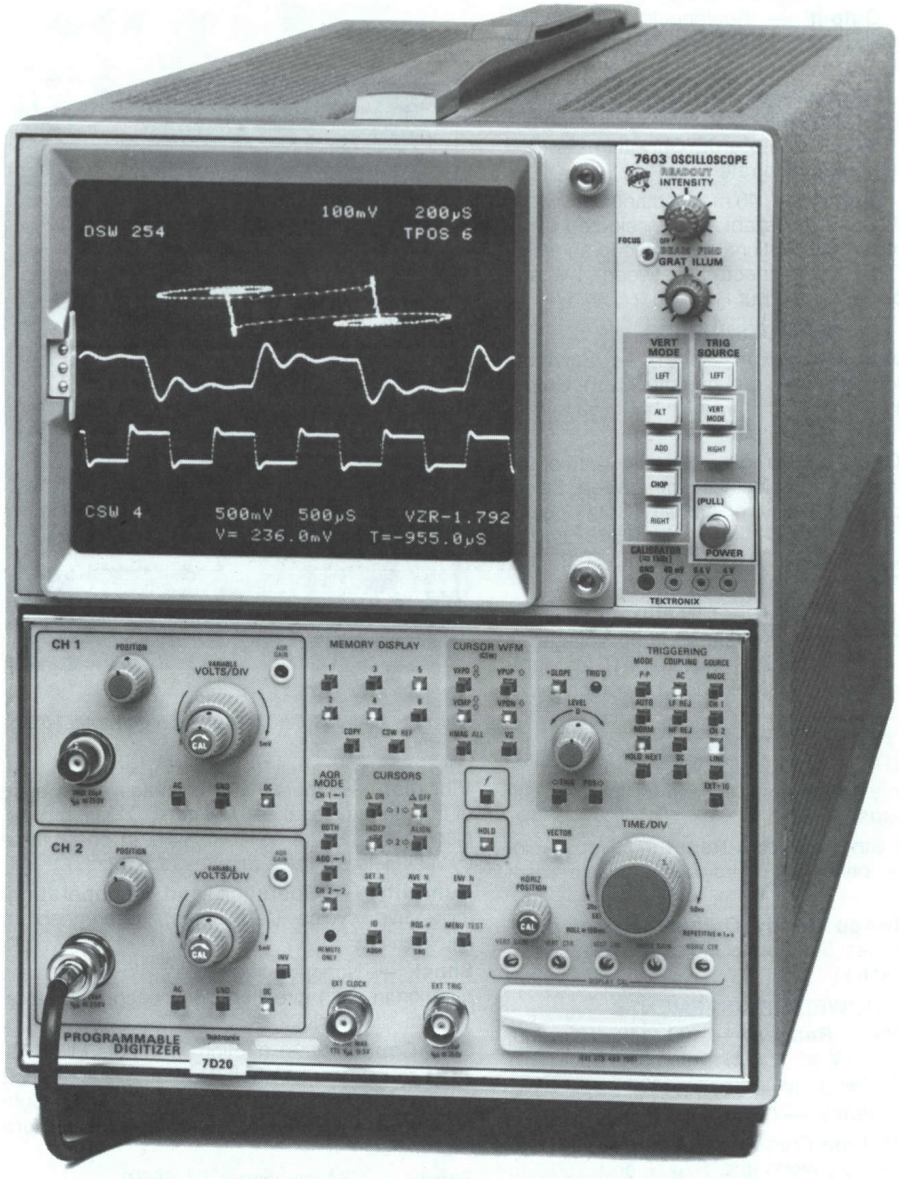
## TYPICAL APPLICATIONS

- **Digital Design and Testing**
- **Communications**
- **Spectrum Analysis**

See page 192 for available Application Notes.

The Tektronix 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100 MHz plug-in oscilloscope market today.

The CRT is large—8 x 10 division (1.22 cm/div)—and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness CRT with a smaller 8 cm x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed. See page 180 for writing speed specifications.




## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Modes** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channels** — One right-hand plug-in compartment. Compatible with all 7000 Series plug-ins.

**Bandwidth** — Dc to 2 MHz.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift is within 2° from dc to 35 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 division (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV. GH (P31) phosphor is standard.

**Option 01, Without CRT readout** — (CRT readout may be added later with conversion kit 040-0654-02).

**Option 04, Maximum Brightness CRT with Reduced Area** — Internal 8 cm x 10 cm graticule with variable illumination. Accelerating potential is 18 kV. GH (P31) phosphor is standard.

**Option 06, Spectrum Analyzer Graticule** — Provides interal spectrum analyzer graticule.

**Option 13, Maximum Brightness CRT with Reduced Area** — Internal 8 cm x 10 cm graticule with BE (P11) phosphor. Accelerating potential 18 kV.

**Optional Phosphors (Specify)** — GM (P7), BE (P11), or GM (P7)/SA (phosphor/spectrum analyzer graticule combination.)

**Typical Photographic Writing Speed*[1]**

| CRT | Camera | Lens | Writing Speed cm/μs |
|---|---|---|---|
| Standard 8 div x 10 div | C-53 | f/1.9 1:0.85 | 122 |
| Opt 13 8 cm x 10 cm | | | 260 |
| Opt 04 8 cm x 10 cm | | | 180 |

*[1] *Using Polaroid Type 107 3,000 ASA film without film fogging.*

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating an offscreen signal.

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

## CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper).

**Voltage Ranges** — 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is ≈1 kHz.

**Current Output** — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks. Output R is 950 Ω.

## OUTPUTS/INPUTS

**+Sawtooth Out (Rear Panel)** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is 950 Ω.

**+Gate Out (Rear Panel)** — Positive gate of the same duration and coincident with sweep. Selectable from Main, Delay, or Auxiliary Gate. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Risetime is 20 ns or less into 50 Ω. Output R is 950 Ω.

**Vertical Signal Out (Rear Panel)** — Selected by Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is 950 Ω. Bandwidth determined by vertical plug-in. See page 190.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**External Single-Sweep Reset** — Ground closure, rear panel BNC provides input to reset sweep.

**Single-Sweep Ready Output** — Rear panel BNC provides 5 V out to indicate single-sweep ready condition.

## POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

**Line Frequency** — 50 Hz to 60 Hz.

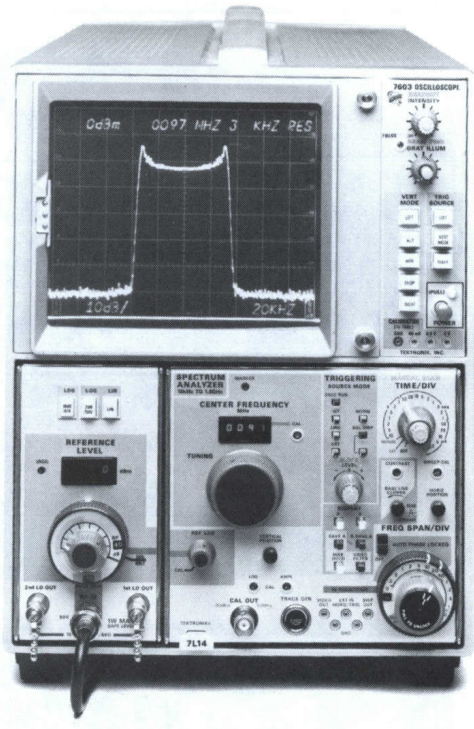
**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the R7603 and 7603 to 50 Hz to 400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan.

## ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).



*The 7L14 converts the 7603 Oscilloscope to a 1.8 GHz Spectrum Analyzer.*

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 0 Hz to 55 Hz to 9 Hz in one minute cycles. Held for three minutes at 55 Hz.

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**EMC Capability** — (Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — CSA certified (CSA 556B).

## PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 221 | 8.7 | 483 | 19.0 |
| Height | 290 | 11.4 | 133 | 5.3 |
| Depth | 610 | 24.0 | 627 | 24.7 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 13.6 | 30.0 | 13.6 | 30.0 |
| Shipping | 20.8 | 46.0 | 19.0 | 42.0 |

*The R7603 requires only 5.25 inches of rack height in a standard 19 inch rack. It is fan cooled and comes complete with slide-out chassis tracks.*

## ORDERING INFORMATION
### (PLUG-INS NOT INCLUDED)

**7603** Oscilloscope **$3,250**

**Includes:** Clear CRT filter (337-1700-04); blue CRT filter (337-1700-01); 20 in two-pin-to-BNC cable (175-1178-00); instruction manual (070-1310-00).

**R7603** Rackmount Oscilloscope **$3,720**

**Includes:** In addition to the above a rackmounting hardware kit (016-0099-00).

### OPTIONS (7603/R7603)

**Option 01** — Without CRT Readout. **−$280**

**Option 03** — EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **+$395**

**Option 04** — Maximum Brightness 8 cm x 10 cm CRT Display. GH (P31) Phosphor is Standard. **+$500**

**Option 05** — Line Frequency Change (50 Hz to 400 Hz). (7603) **+$315**
(R7603) **+$300**

**Option 06** — With Internal Spectrum Analyzer Graticule. **+$50**

**Option 08** — (7603 only) Protective Panel Cover. **+$115**

**Option 13** — Maximum Brightness 8 cm x 10 cm CRT Display with BE (P11) Phosphor. **+$600**

**Option 20** — (R7603 only) IEEE Standard 488 Interface for the 7D20 only. (Deletes rear panel + sawtooth out, + gate out, and vert sig out.) **+$105**

**Option 76** — GM (P7) Phosphor. **+$100**

**Option 77** — GM (P7) Phosphor with Internal Spectrum Analyzer Graticule. **+$100**

**Option 78** — BE (P11) Phosphor. **+$100**

### CONVERSION KITS (7603/R7603)

**CRT Readout** — (7603) Order 040-0654-02 **$650**
(R7603) Order 040-0674-02 **$650**

**EMC Capability** — (7603) Order 040-1000-00 **$375**
(R7603) Order 040-0955-00 **$375**

**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 **$70**

**X-Y Horizontal Comp** — Order 040-0718-00 **$390**

### INTERNATIONAL POWER PLUG OPTIONS (7603 and R7603)

**Option A1**— Universal Euro 222 V/16A, 50 Hz.
**Option A2** — UK 240 V/13A, 50 Hz.
**Option A3** — Australian 240 V/10A, 50 Hz.
**Option A4** — North American 240 V/15A, 60 Hz.
**Option A5** — Switzerland 220 V/10A, 50 Hz.

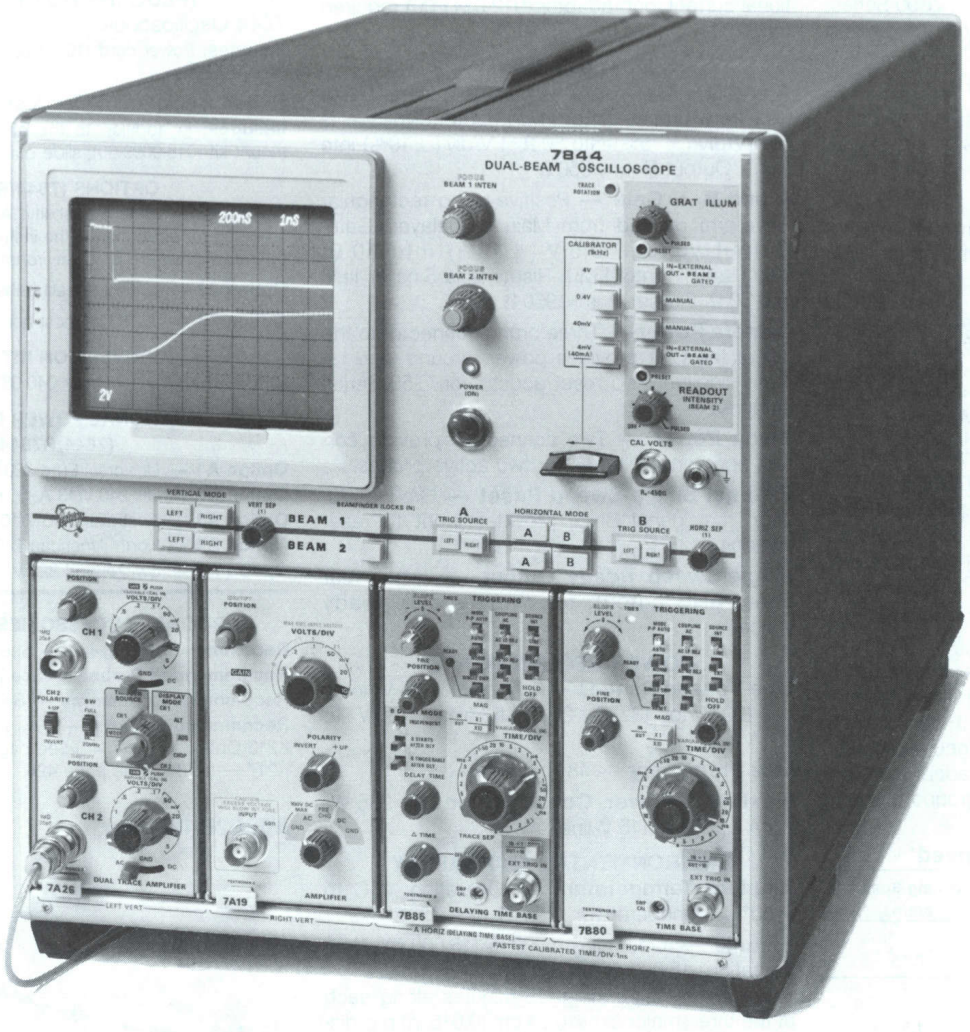
## OPTIONAL ACCESSORIES (7603/R7603)

Field installable Option 20 (R7603 only) intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's IEEE Standard 488 Interface to the R7603 mainframe.
Order 040-1093-00 **$380**

Five other field installable kits are available, one for each of the international power plug options, A1-A5. Contact your local Tektronix Sales Office for information.

**A1** — Universal Euro. Order 040-1094-00 **$345**
**A2** — UK. Order 040-1095-00 **$300**
**A3** — Australian. Order 040-1096-00 **$300**
**A4** — North American. Order 040-1097-00 **$300**
**A5** — Switzerland. Order 040-1098-00 **$300**

**Recommended Plug-ins** — See page 190.
**Recommended Probes** — See pages 191 and 426.
**Recommended Cameras** — See pages 192 and 406.
**Recommended Carts** —
K213 Option 12 — (7603) See page 424.
K217 — (R7603) See page 424.




# 7844/R7844

**400 MHz Bandwidth**

**900 ps Risetime**

**1 ns/division Fastest Calibrated Sweep Rate**

**Greater than 1.5 cm/μs Writing Speed**

**8 cm x 10 cm Display**

**CRT Readout**

**True Dual Beam (Dual-Gun)**

**Full Vertical Crossover Switching**

## TYPICAL APPLICATIONS

* **Radar/Lidar**
* **Destructive Testing**
* **SCR Switching**

See page 192 for available Application Notes.

The 7844 and seven inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed CRT readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds. See page 180 for photographic writing speed specifications.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Logic**

| | Beam 1 | Beam 2 |
|---|---|---|
| Vertical Compartment Controlling Beam | Left | Left |
| | Left | Right |
| | Right | Left |
| | Right | Right |

**Crossover** — Permits viewing the same signal on two time bases.

**Trace Separation** — Beam 1 can be positioned ±4 cm with respect to Beam 2.

**Delay Line** — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series time bases. Not compatible with 7B50 Series.

## HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments. Compatible with 7B80 Series, 7B90 Series, 7000 Series vertical amplifiers, and specialized plug-ins.

**Bandwidth** — Dc to at least 1 MHz.

**Fastest Calibrated Sweep Rate** — 1 ns/div.

**X-Y Mode** — Phase shift is within 2° from dc to 50 kHz.

**Horizontal Separation** — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

**Display Logic**

| Beam 1 | Beam 2 |
|---|---|
| A Horizontal | A Horizontal |
| A Horizontal | B Horizontal |
| B Horizontal | A Horizontal |
| B Horizontal | B Horizontal |

## CRT AND DISPLAY FEATURES

**CRT** — Dual beam, full overlap. 8 cm x 10 cm graticule with variable illumination. CRT readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV. GH (P31) phosphor.

**Option 78, BE (P11) Phosphor** — Replaces standard GH (P31) phosphor.

**Pulsed Readout and Graticule Illumination** — Provides a means of pulsing the graticule lights and CRT readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights and CRT readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

**Typical Photographic Writing Speed*[1]**

| CRT | Camera | Lens | Writing Speed cm/ns |
|---|---|---|---|
| Standard 8 cm x 10 cm | C-51 | f/1.2 | 0.75 |
| Opt 78 8 cm x 10 cm | | 1:0.5 | 1.5 |

*[1] *Using Polaroid Type 107 3000 ASA film without film fogging.*

The photographic writing speed enhancer, Option 22, provides a preset automatic method of film fogging for the 7844. Option 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder (Beam 1 and Beam 2, Independent Controls)** — Aids in locating off screen signal.

**External Z-Axis Input (Beam 1 and Beam 2)** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac), p-p ac and dc coupled.

## CALIBRATOR

**Voltage Output** — Rectangular waveform positive-going from ground, 1 kHz (±0.25%).

**Voltage Ranges** — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

**Current Output** — 40 mA (±1%) rectangular waveshape. Front panel current loop on 7844; optional current loop adaptor (012-0341-00) required for R7844. Output R is 450 Ω.

## OUTPUTS/INPUTS

**A and B + Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is ≈950 Ω.

**A and B + Gate** — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime is 5 ns or less into 50 Ω. Output R is ≈950 Ω.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series cameras.

**Probe Power** — Two connectors provide correct operating voltages for two active probes.

**External Single-Sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweeps.

**Single-Sweep Ready Output** — +5 V, rear panel BNC output, for single-sweep ready indication.

## POWER REQUIREMENTS

**Line Voltage Ranges** — Selectable 115 V nominal (90 V to 132 V), 230 V nominal (180 V to 264 V).

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 235 W, 2.9 A at 60 Hz 115 V line.

## ENVIRONMENTAL AND SAFETY

**Ambient Termperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**EMC Capability** — (Option 03) Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

## PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 305 | 12.0 | 483 | 19.0 |
| Height | 328 | 12.9 | 178 | 7.0 |
| Depth | 605 | 23.8 | 630 | 24.8 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 16.3 | 36.0 | 15.0 | 33.0 |
| Shipping | 21.3 | 47.0 | 28.5 | 63.0 |

## ORDERING INFORMATION
### (PLUG-INS NOT INCLUDED)

**7844** Oscilloscope **$14,995**

**Includes:** Power cord (161-0066-00); instruction manual (070-1676-02).

**R7844** Rackmount Oscilloscope **$15,450**

**Includes:** In addition to the above a hardware rackmount kit (016-0099-00); slide guide (351-0314-01).

### OPTIONS (7844/R7844)

**Option 03** — EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMC environments. **$395**

**Option 22** — Writing Speed Enhancer. **+$400**

**Option 78** — BE (P11) Phosphor. **+$100**

### CONVERSION KIT (7844)

**EMC Capability** — Order 040-0834-01 **$535**

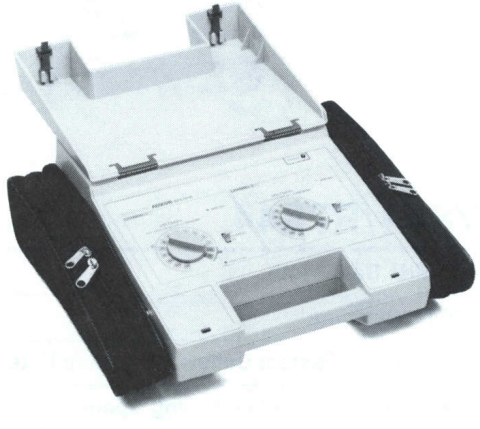
### INTERNATIONAL POWER PLUG OPTIONS (7844/R7844)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES (7844/R7844)

**Recommended Plug-ins** — See page 190.
**Recommended Probes** — See pages 191 and 426.
**Recommended Cameras** — See pages 192 and 406.
**Recommended Carts** —
K213 Option 12 — (7844) See page 424.
K217 — (R7844) See page 424.

## A6902B Isolator



A dual-channel, optical and transformer-coupled voltage isolator, the A6902B allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

Designed for use with any dual-channel oscilloscope, the A6902B permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages.

See page 437 for a complete description.

# 7000 SERIES
# CRT STORAGE MAINFRAMES

Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≈0.03 cm/μs for mechanical, spectrum analysis, or TDR applications, to 2500 cm/μs for capturing fast single events such as high speed digital logic. A selection of storage modes offers the following features:

**Bistable ..... Long View Time**

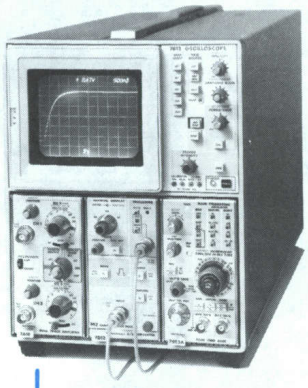
**Variable Persistence ..... High Contrast Displays**

**FAST Bistable .... Captures Fast Single or Multiple Events**

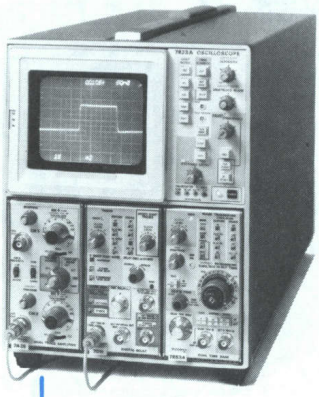
**FAST Variable Persistence ..... Provides Maximum Stored Writing Rate**

## CONTENTS

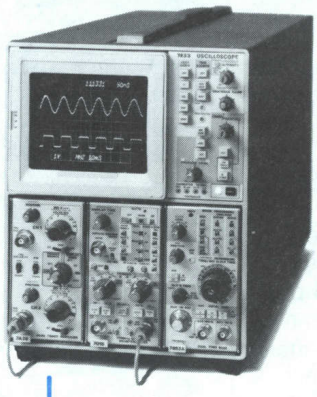

7834 Fast Storage ..... 206
7633/R7633 Multimode Storage ..... 208
7623A/7623A Multimode Storage ..... 208
7613/R7613 Variable Persistence Storage .. 210
Nonstorage Mainframes ..... 193
CRT Storage Mainframes ..... 205
Plug-Ins ..... 212
High Performance Digitizing Mainframes ..... 306

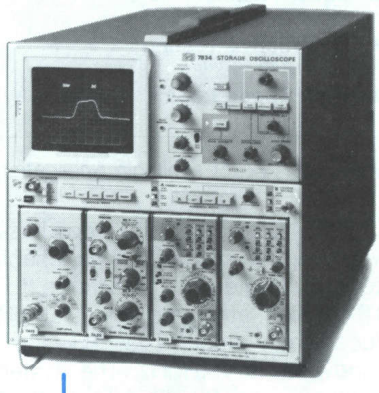
**7613**
Variable
Persistence



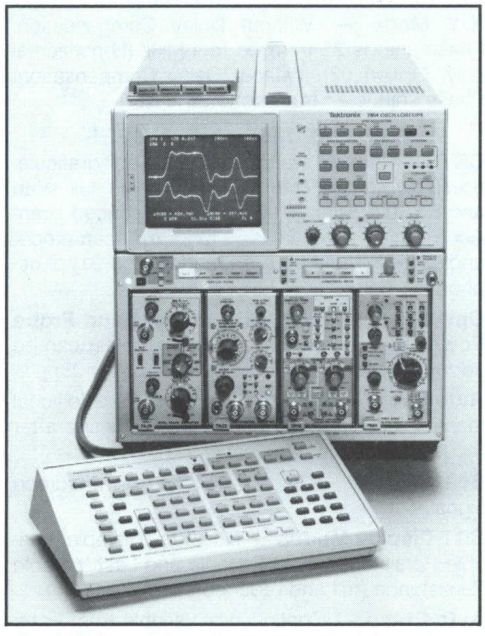
**7623A**
FAST
Multimode



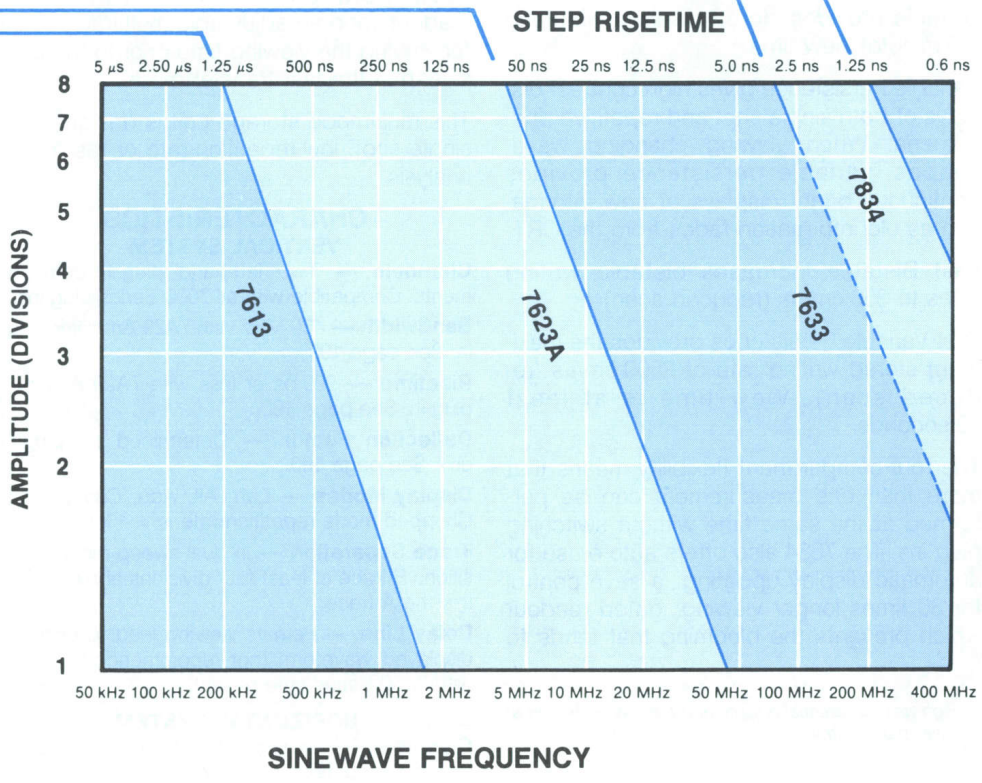
**7633**
FAST
Multimode



**7834**
FAST
Multimode



*7854 Digital Storage (400 MHz Waveform Processing).*
*See page 318.*



# 7834

**Dc to 400 MHz Bandwidth**

**900 ps Risetime**

**1 ns/div Fastest Calibrated Sweep Rate**

**2500 cm/μs Stored Writing Speed**

**Stores Single-Shot Risetimes as Fast as 1.4 ns**

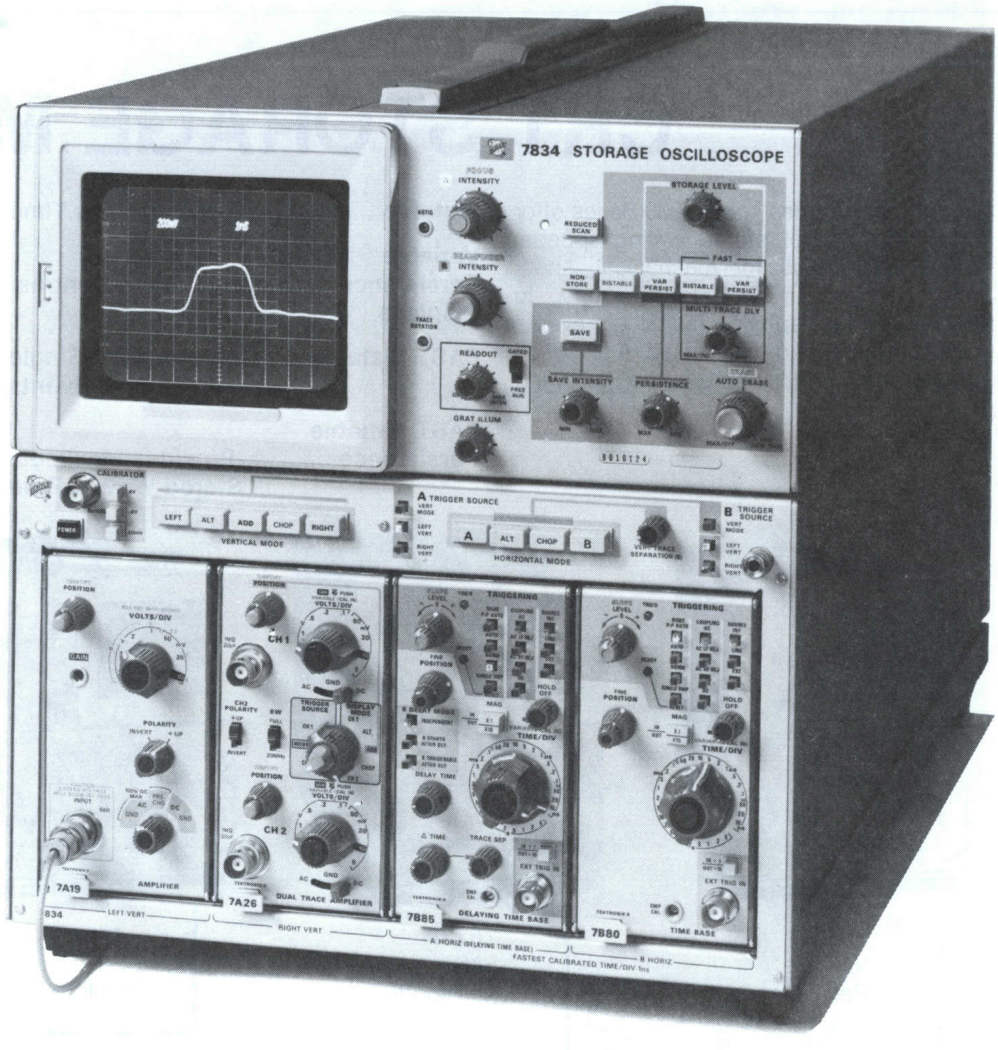
**Multimode Storage**

**Long View Time**

## TYPICAL APPLICATIONS

* **Laser Fusion**
* **Destructive Testing**
* **High Speed Logic**

See page 192 for available Application Notes.




The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/μs, enabling storage of single-shot risetimes to 1.4 ns, 3.6 cm high, at eight-divisions amplitude, reduced-scan mode. The 7834's mainframe bandwidth is 400 MHz. The system bandwidth may vary from 75 MHz to 400 MHz depending on the plug-in selected.*[1]

This instrument has four storage modes: Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence.

Bistable provides stored displays with long (30 minute) view time.

Variable Persistence gives high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, variable persistence provides continuous bright displays of new information as old information fades from the CRT.

Fast Bistable increases bistable writing rates to 350 cm/μs (reduced scan).

Fast Variable Persistence provides the maximum stored writing rate of 2500 cm/μs (reduced scan). View time is at least 30 seconds.

The four-compartment flexibility means that more than one measurement can be performed at the same time without switching plug-ins. The 7834 also offers auto-erase for automatic display updating...a save control for 30 times longer viewing...gated readout which prevents the blooming that tends to occur between sweeps with nongated readout...and an adjustable multitrace delay for varying the viewing time prior to the next sweep in the fast transfer mode.

This multimode storage unit is designed for single shot, low-repetition-rate or fast pulse analysis.

*[1] *High gain differential amplifiers offer very high gain at lower bandwidths.*

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Bandwidth** — 400 MHz with 7A29 Amplifier plug-in. See page 190.

**Risetime** — 900 ps or less with 7A29 Amplifier plug-in. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Modes** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

**Trace Separation** — In dual-sweep modes, positions B trace at least four divisions above or below the A trace.

**Delay Line** — Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments. Compatible with all 7000 Series plug-ins.

**Bandwidth** — Dc to at least 1 MHz.

**Display Modes** — A, Alt, Chop, B. Chopped mode repetition rate is ≈200 kHz.

**Fastest Calibrated Sweep Rate** — 1 ns/div.

**X-Y Mode** — Without Delay Compensation: Phase shift is 2° from dc to 1 MHz (B horizontal only, Option 02). Without Delay Compensation: Phase shift is 2° from dc to 35 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal variable illuminated graticule. 8 x 10 division (0.9 cm/div) graticule in full scan and 8 x 10 division (0.45 cm/div) in reduced scan. Accelerating potential is ≈10 kV full scan mode, and 12 kV in reduced scan mode. GH (P31) phosphor standard.

**Option 01, Without CRT Readout and Probe Power** — CRT readout and probe power can be added later with conversion kit (040-0811-03).

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating an offscreen signal.

**CRT Display Modes** — Nonstore, Bistable, Variable Persistence, Fast Bistable and Fast Variable Persistence (full and reduced scan).

**Auto Erase** — Continuously variable from <1 s to >10 s.

**Multitrace Delay** — Adjusts the transfer cycle time in the fast transfer modes. Continuously variable from <1 s to >4 s.

**Presistence** — (Variable Persistence Mode only) Controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

**Save** — Prevent accidental erasure of display and extends view time up to 30 times longer in all modes.

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

### Storage Writing Speed

**Full Scan (Center 6 div x 8 div at 0.9 cm/div)**

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Stored Writing Speed | 270 cm/μs (300 div/μs) | 45 cm/μs (50 div/μs) | 1.8 cm/μs (2 div/μs) | 0.03 cm/μs (.03 div/μs) |
| View Time | 30 s*1 | 30 min*2 | 30 s*1 | 30 min |
| ≈Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

**Reduced Scan (Center 8 div x 10 div at 0.45 cm/div)**

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Stored Writing Speed | 2500 cm/μs (5,500 div/μs) | 350 cm/μs (776 div/μs) | 5.4 cm/μs (12 div/μs) | 0.09 cm/μs (0.2 div/μs) |
| View Time | 30 s*1 | 30 min*2 | 30 s*1 | 30 min*1 |
| ≈Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

*1 *View times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

*2 *Save intensity at minimum.*

**Fast Variable Persistence Writing Speed**

| Scan Mode | Sweep Speed | Peak-to-Peak Sinewave | Step Response |
|---|---|---|---|
| Reduced Scan 5,500 div/μs (0.45 cm/div) | ≥1 ns/div | 7.1 div 250 MHz | 7.7 div 1.4 ns |
| | | 8 div 221 MHz | 8 div 1.45 ns |
| Full Scan 300 div/μs (0.9 cm/div) | ≥10 ns/div | 3.2 div 30 MHz | 3 div 10 ns |
| | | 6.4 div 15 MHz | 5 div 16.6 ns |

### CALIBRATOR

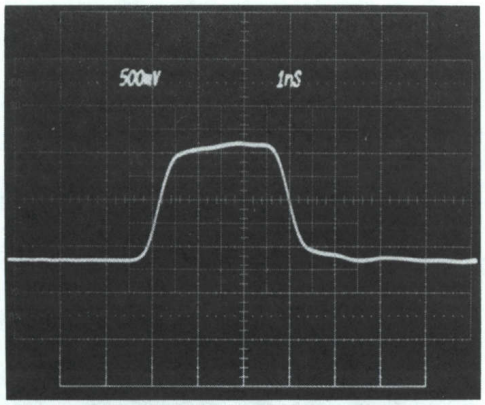
**Voltage Output** — Squarewave, positive-going from ground.

**Voltage Range** — 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within 0.25%.

**Current Output** — 40 mA squarewave with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

### OUTPUTS/INPUTS

**+Sawtooth** — Starts 1 V or less from ground into 1 MΩ. Output voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.




*Readout is stored with the waveform on several CRT storage scopes including the 7613, 7623A, 7633 and 7834 (shown). Multimode storage is available on the 7623A, 7633, and 7834.*

**+Gate** — Positive going waveform of the same duration and coincident with sweep selectable from A Gate, B Gate or A Delayed Gate. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω.

**Vertical Signal Out** — Selected by A Trigger Source switch. Output voltage is 0.5 V into 1 MΩ, 25 mV into 50 Ω. Output R is ≈950 Ω.

**Bandwidth** — Determined by vertical plug-in. See page 190.

**Remote Single Sweep Reset, Remote Save and Remote Erase** — Rear panel BNC connector inputs, ground closure activated.

**Remote Fast Transfer Gate** — TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Probe Power** — Two rear-panel connectors for two active probes.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 215 W.

### ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for three minutes at 55 Hz, referenced to MIL-T-28800C.

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

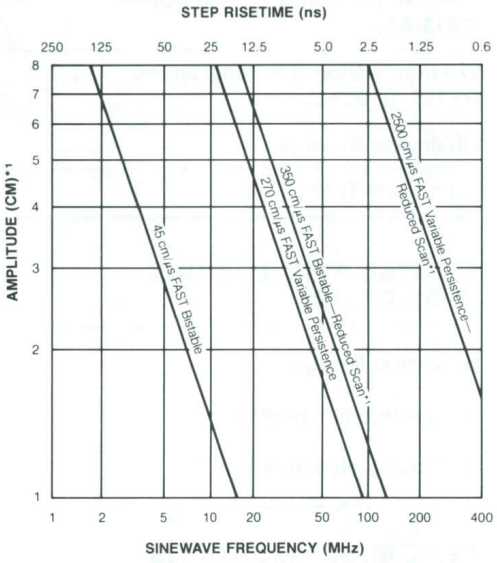
**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks, referenced to MIL-T-28800C.

**EMC Capabilty** — Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 305 | 12.0 |
| Height | 345 | 13.6 |
| Depth | 589 | 23.2 |
| **Weights ≈** | **kg** | **lb** |
| Net | 16.1 | 35.5 |
| Shipping | 21.3 | 47.0 |




*Graph showing the stored writing speed needed to display a give sinewave or step risetime at a given amplitude.*

*1 *Reduced Scan divisions are 0.45 cm.*

## ORDERING INFORMATION
### (PLUG-INS NOT INCLUDED)

**7834** Storage Oscilloscope **$13,365**

**Includes:** Installed gray CRT filter (378-0625-02); green CRT filter (378-0625-08); power cord (161-0066-00); instruction manual (070-1988-00).

#### OPTIONS

**Option 01** — Without CRT Readout and Probe Power. **−$280**

**Option 02** — X-Y Mode Phase Correction. Adds an X-Y delay compensation network that equalizes the signal delay between either vertical compartment and the B horizontal compartment. **+$260**

**Option 03** — EMC Capability. Adds special shielding for protection to the instrument when operated in sever EMC environments. **+$395**

#### CONVERSION KITS

**CRT Readout** — Order 040-0811-05 **$605**

**X-Y Mode Phase Correction** — Order 040-0942-01 **$195**

**EMC Capability** — Order 040-0880-00 **$375**

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES

**Cradle Mount Adaptor** — For Rackmounting. Order 040-0560-00 **$445**

**Recommended Plug-ins** — See page 190.
**Recommended Probes** — See pages 191 and 426.
**Recommended Cameras** — See pages 192 and 406.
**Recommended Cart** — K213 Option 12 — See page 424.

# 7633/R7633 & 7623A/R7623A

**Dc to 100 MHz Bandwidth**

**3.5 ns Risetime**

**5 ns/div Fastest Calibrated Sweep Rate**

**1000 cm/μs Stored Writing Speed (7633/R7633)**

**135 cm/μs Stored Writing Speed (7623A/R7623A)**

**Multimode Storage**

**Long View Time**

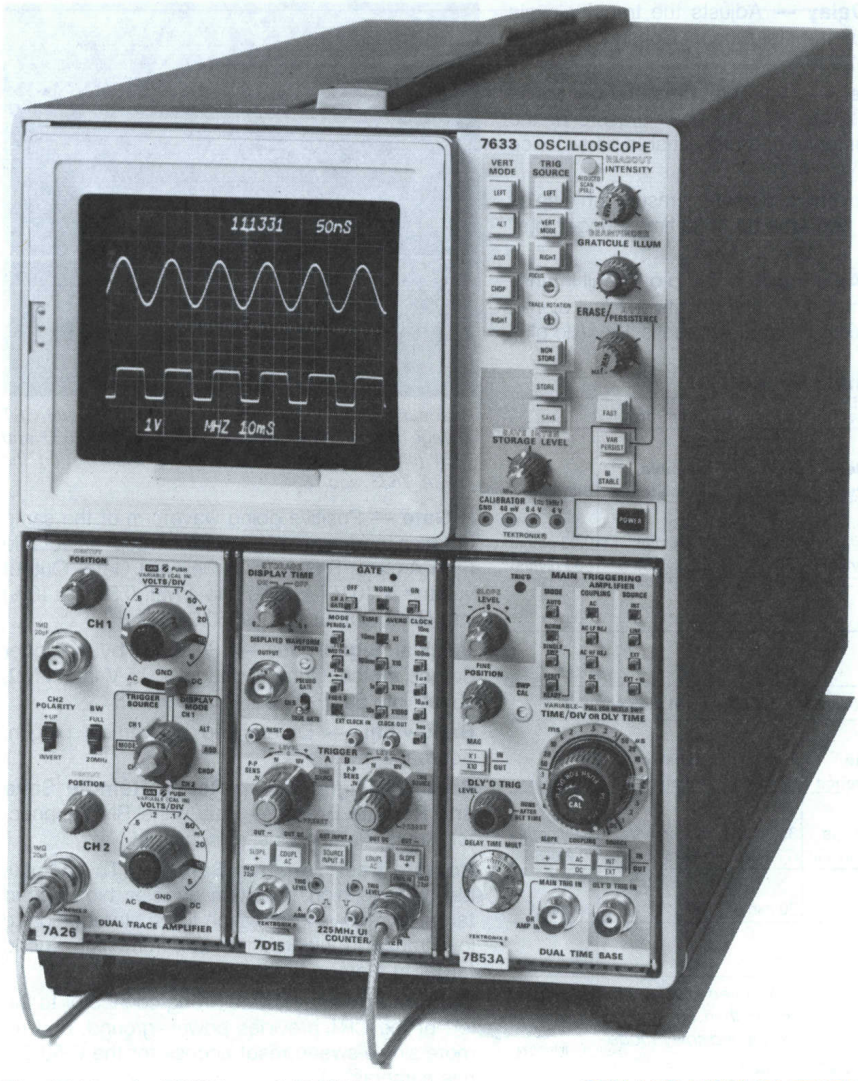
## TYPICAL APPLICATIONS (7633/R7633)

* **Digital Design**
* **Destructive Testing**
* **Communications**

## TYPICAL APPLICATIONS (7623A/R7623A)

* **Ultrasonics**
* **Power Supply Design**
* **Component Testing**

See page 192 for available Application Notes.




The Tektronix 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100 MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The maximum writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

This multimode storage instrument allows for retention and viewing for fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms.

The R7633 and R7623A require only 5.25 inches of rack height in a standard 19 inch rack. They are fan cooled and come complete with slide-out chassis tracks.

Characteristics are common to the 7633/R7633 and the 7623A/R7623A unless noted.

The Tektronix 7623A and R7623A Storage Oscilloscope have all the features and performance of the 7633/R7633 except the reduced scan mode.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins. See page 190.

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Modes** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channel** — One right-hand plug-in compartment. Compatible with all 7000 Series plug-ins. See page 190.

**Bandwidth** — Dc to at least 2 MHz.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — Phase shift <2° from dc to 35 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 division (0.9 cm/div) and 8 x 10 division (0.45 cm/div) graticule with variable illumination. Accelerating potential is ≈8.5 kV in normal mode, 10 kV in reduced scan mode. GH (P31) phosphor standard.

**Option 01, Without CRT readout** — CRT readout can be added later with a conversion kit (040-0748-01 for 7633/7623A or 040-0759-01 for R7633/R7623A).

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating an offscreen signal.

**CRT Display Modes** — Nonstore, Bistable, Variable Persistence, Fast Bistable, Fast Variable Persistence. Full or reduced scan may be selected on the 7633 in all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

**Auto Erase** — Continuously variable to >10 s.

**Save** — Prevents accidental erasure of display and extends view time up to 30 times longer in all modes.

**Persistence** — (Variable Persistence mode only) controls rate of continous erasure of the variable persistence and fast variable persistence stored displays.

**External Z-Axis Input** — 2 V p-p for useful intensity range from dc to 2 MHz. Intensity range diminishes to 20% of full range at 10 MHz. Positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

### Storage Writing Speed
### Full Scan (7633/R7633 and 7623A/R7623A)

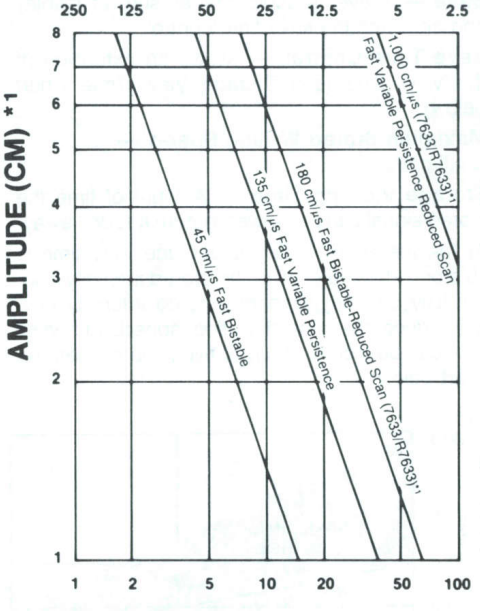
| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Stored Writing Speed | 135 cm/μs | 45 cm/μs | 0.45 cm/μs | 0.03 cm/μs |
| View Time | 30 s*1 | 30 min minimum | 30 s*1 | 30 min minimum |
| ≈ Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

### Reduced Scan (7633/R7633 Only)

| Display Mode | Fast Variable Persistence | Fast Bistable | Variable Persistence | Bistable |
|---|---|---|---|---|
| Store Writing Speed | 1000 cm/μs | 180 cm/μs | 1.35 cm/μs | 0.09 cm/μs |
| View Time | 30 s*1 | 30 min minimum | 30 s*1 | 30 min minimum |
| ≈ Erase Time | 1.4 s | 1.4 s | 0.9 s | 0.9 s |

*1 *These times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the Save display mode.*

**STEP RISETIME (ns)**




*Graph showing the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.*

*1 *Reduced Scan divisions are 0.45 cm.*

### Fast Variable Persistence Writing Speed

| Scan Mode | Sweep Speed | Peak-to-Peak Sinewave | Step Response |
|---|---|---|---|
| Reduced Scan*1 2200 div/μs (0.45 cm/div) | ≥5 ns/div | 7.1 div 100 MHz 8 div 89 MHz | 7.7 div 3.5 ns 8 div 3.7 ns |
| Full Scan*2 150 div/μs (0.9 cm/div) | ≥50 ns/div | 3.2 div 15 MHz 6.4 div 7.5 MHz | 3 div 20 ns 5 div 33 ns |

*1 *Applies to 7633/R7633 only.*
*2 *Applies to 7633/R7633 and 7623A/R7623A.*

## CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper).

**Voltage Ranges** — 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Repetition rate is ≈1 kHz.

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks. Output R is ≈450 Ω.

## OUTPUTS/INPUTS

**+Sawtooth** — Sawtooth starts 1 V or less from ground into 1 MΩ. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

**+Gate** — Positive-going waveform of the same duration and coincident with sweep selectable from main, delay, or auxiliary gate.. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%,) into 1 MΩ. Risetime is 20 ns or less into 50 Ω. Output R is 950 Ω within 2%.

**Vertical Signal Out** — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is 950 Ω within 2%. Bandwidth is determined by vertical plug-in. See page 190.

**Camera Power Output** — Three-prong connector to the left of the CRT provides power, ground and remote single-sweep reset access for the C-50 Series cameras.

**External Single-Sweep Reset** — Ground closure; rear panel BNC input to reset sweep.

**Remote Erase** — Rear panel BNC connector inputs, ground closure activated.

## POWER REQUIREMENTS

**Line Voltage Ranges** — 100 V, 110 V, 120 V, 200 V, 220 V, and 240 V ac ±10%; internally selectable with quick change jumpers.

**Line Frequency** — 50 Hz to 60 Hz.

**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the 7633, R7633, 7623A and R7623A to 50 Hz to 400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for all models.

## ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to + 75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for three minutes at 55 Hz (MIL-T-28800B).

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks (MIL-T-28800C).

**EMC Capability** — Meets MIL-STD-461A requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

## PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| Dimensions | mm | in | mm | in |
| Width | 221 | 8.7 | 483 | 19.0 |
| Height | 305 | 12.0 | 133 | 5.3 |
| Depth | 597 | 23.5 | 566 | 22.3 |
| Weights ≈ | kg | lb | kg | lb |
| Net | 13.6 | 30.0 | 14.5 | 32.0 |
| Shipping | 19.0 | 42.0 | 28.2 | 62.0 |

## ORDERING INFORMATION
### (PLUG-INS NOT INCLUDED)

**7633 Storage Oscilloscope** **$8,995**
**Includes:** 20 in two-pin-to-BNC cable (175-1178-00); power cord (161-0066-00); green CRT filter (378-0625-08); instruction manual (070-1767-00).

**R7633 Storage Oscilloscope** **$9,505**
**Includes:** Same as 7633 plus rackmounting hardware.

**7623A Storage Oscilloscope** **$6,795**
**Includes:** Same as 7633, instruction manual replaced with 070-1685-00.

**R7623A Storage Oscilloscope** **$7,240**
**Includes:** Same as 7633 plus rackmounting hardware, instruction manual replaced with 070-1685-00.

### OPTIONS (7633/R7633/7623A/R7623A)

**Option 01** — Without CRT Readout. **−$280**
**Option 03** — EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMI environments. **+$375**
**Option 08** — (7633/7623A) Protective Panel Cover. **+$105**
**Option 05** — Line Frequency Change (50 Hz to 400 Hz). **+$315**
**Option 23** — (7633/7623A only) VDE RPM Mark. **+$50**

### CONVERSION KITS (7633/R7633/7623A/R7623A)

**CRT Readout** —
(7633/7623A) Order 040-0748-01 **$650**
(R7633/R7623A) Order 040-0759-01 **$650**

**EMC Capability** —
(7633/7623A) Order 040-0663-01 **$375**
(R7633/R7623A) Order 040-0678-01 **$375**

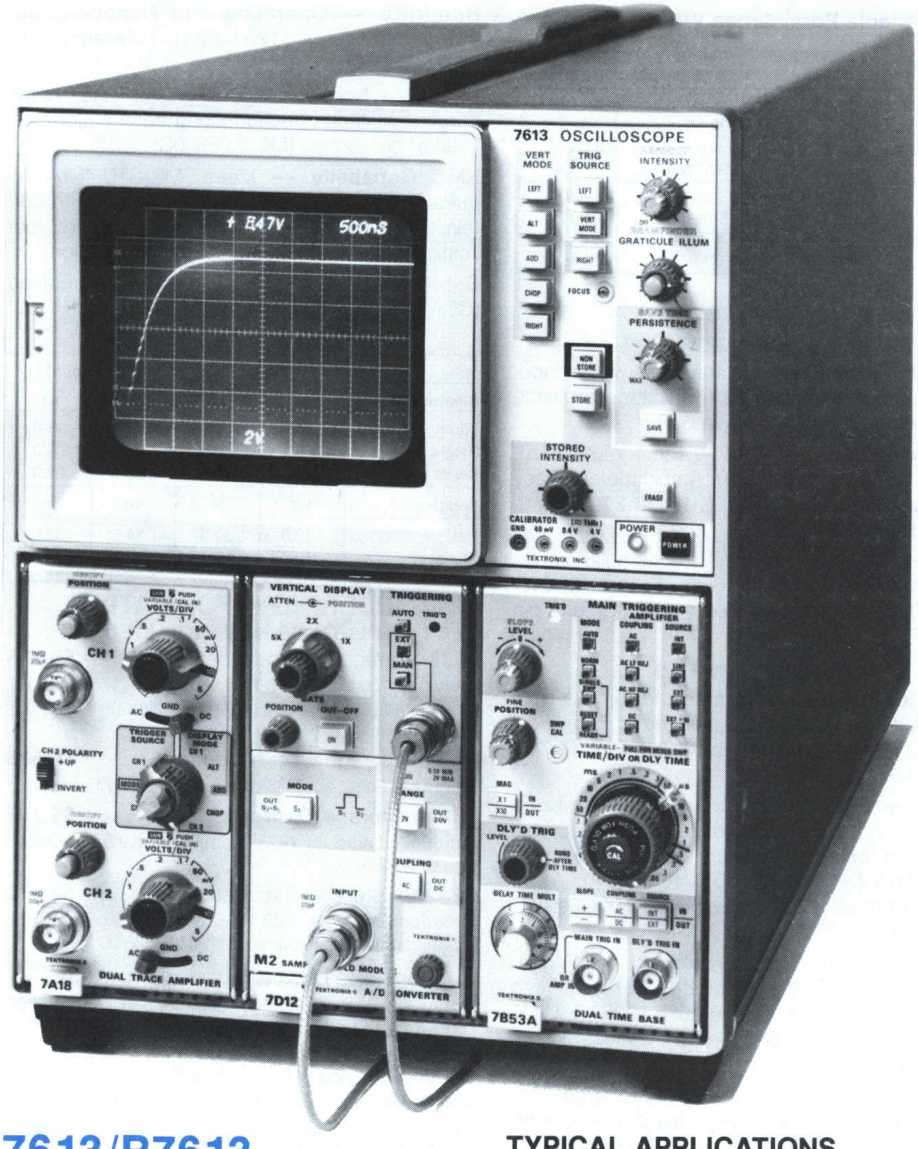
**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 **$70**

### INTERNATIONAL POWER PLUG OPTIONS (7633/R7633/7623A/R7623A)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES (7633/R7633/7623A/R7623A)

**Recommended Plug-ins** — See page 190.
**Recommended Probes** — See pages 191 and 426.
**Recommended Cameras** — See pages 192 and 406.
**Recommended Carts** —
K213 Opt 12 — (7633/7623A) See page 424.
K217 — (R7633/R7623A) See page 424.




# 7613/R7613

**Dc to 100 MHz Bandwidth**

**3.5 ns Risetime**

**5 ns/div Fastest Calibrated Sweep Rate**

**4.5 cm/μs Stored Writing Speed**

**Variable Persistence Storage**

**Long View Time**

**5.25 Inch Rackmount Height**

## TYPICAL APPLICATIONS

* **Audio**
* **Mechanical Transducers**
* **Spectrum Analysis**

See page 192 for available Application Notes

The Tektronix 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/μs or nonstorage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 division (0.9 cm/div).

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments. Compatible with all 7000 Series plug-ins. See page 190.

**Bandwidth** — Determined by mainframe and plug-in unit. See page 190.

**Risetime** — Determined by mainframe and plug-in unit. See page 190.

**Deflection Factor** — Determined by plug-in unit. See page 190.

**Display Modes** — Left, Alt, Add, Chop, Right. Chopped mode repetition rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Channel** — One right-hand plug-in compartment. Compatible with all 7000 Series plug-ins. See page 190.

**Bandwidth** — Dc to at least 2 MHz.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — Phase shift is within 2° from dc to 35 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 division (0.9 cm/div) graticule with variable illumination. Accelerating potential is 8.5 kV. GH (P31) phosphor.

**Option 01, Without CRT Readout** — CRT readout can be added later with a conversion kit (040-1656-02 for 7613 or 040-0676-02 for R7613).

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Aids in locating an offscreen signal.

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 2 MHz. Intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

**CRT Display Modes** — Nonstore, Variable Persistence.

**Erase Time** — 0.5 s or less.

**Persistence** — (Variable) Controls rate of continuous erasure of stored displays.

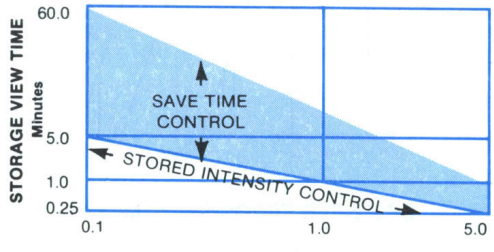
**Save** — Prevents accidental erasure of display and activates the save time control.

**Save Time Control** — Allows an extension of the view time (see Storage View Time Chart below).

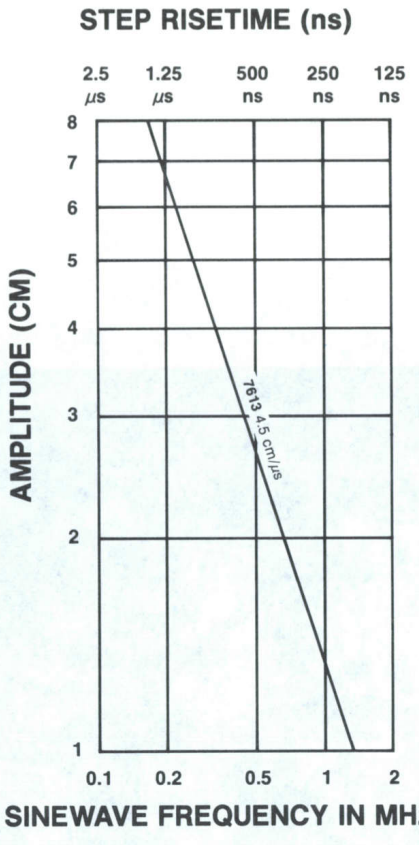
**Maximum Stored Writing Speed** — >4.5 cm/μs.

**Storage Viewing Time** — Amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 s or 0.25 minutes with the stored intensity control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to five minutes (see the chart below).




**STORED WRITING SPEED (div/μs at MAXIMUM PERSISTENCE)**




*Graph showing the stored writing speed needed for a given sinewave or step risetime at a given amplitude.*

## CALIBRATOR

**Voltage Output** — Rectangular waveshape, positive-going from ground. (Dc voltage available when selected by internal jumper.)

**Voltage Ranges** — 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (15°C to 35°C); within 2% (0°C to 50°C). Repetition rate is ≈1 kHz within 0.20%.

**Current Output** — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

## OUTPUTS/INPUTS

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

**+Gate** — Positive-going waveform pulse of the same duration and coincident with sweep. Selectable from main, delay, or auxiliary gate. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω. Output R is 950 Ω within 2%.

**Vertical Signal Out** — Selected by Trigger Source switch. Output voltage is 25 mV/div into 50 Ω, 0.5 V/div into 1 MΩ. Output R is 950 Ω within 2%. Bandwidth is determined by vertical plug-in. See page 190.

**Camera Power Output** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**External Single-Sweep Reset** — Ground closure; rear panel input to reset sweep.

**Remote Erase** — Ground closure; rear panel BNC provides input to erase stored trace.

## POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick change jumpers.

**Line Frequency** — 50 Hz to 60 Hz.

**Option 05, Line Frequency Change (50 Hz to 400 Hz)** — Converts the 7613 and R7613 to 50 Hz to 400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

## ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to + 75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

Vibration — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz (MIL-T-28800C).

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours), referenced to MIL-E-16400F.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks (MIL-T-28800C).

**EMC Capability** — Meets MIL-STD-461B requirements when tested in accordance with certain test methods of MIL-STD-462. Contact your Tektronix representative for more information.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

## PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 221 | 8.7 | 483 | 19.0 |
| Height | 305 | 12.0 | 133 | 5.3 |
| Depth | 597 | 23.5 | 566 | 22.3 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 13.6 | 30.0 | 14.5 | 32.0 |
| Shipping | 19.0 | 42.0 | 28.2 | 62.0 |

## ORDERING INFORMATION
### (PLUG-INS NOT INCLUDED)

**7613** Storage Oscilloscope **$5,850**

**Includes:** 20 in two-pin-to-BNC cable (175-1178-00); gray CRT filter (378-0625-02); power cord (161-0066-00); instruction manual (070-1463-01).

**R7613** Storage Oscilloscope **$6,315**

**Includes:** Same as 7613 plus rackmounting hardware.

### OPTIONS (7613/R7613)

**Option 01** — Without CRT Readout. **−$280**

**Option 03** — EMC Capability. Adds special shielding for protection to the instrument when operated in severe EMI environments. **+$375**

**Option 05** — Line Frequency Change (50 Hz to 400 Hz). **+$315**

**Option 06** — Special Internal Graticule (Spectrum Analyzer). **+$50**

**Option 08** — (7613 only) Protective Panel Cover. **+$115**

**Option 23** — (7613 only) VDE RPM Mark. **+$50**

### CONVERSION KITS (7613/R7613)

**CRT Readout** —
(7613) Order 040-0656-02 **$650**
(R7613) Order 040-0676-02 **$650**

**EMC Capability** —
(7613) Order 040-0663-01 **$375**
(R7613) Order 040-0678-01 **$375**

**Line Frequency Change** —
Order 040-0687-02. **$230**

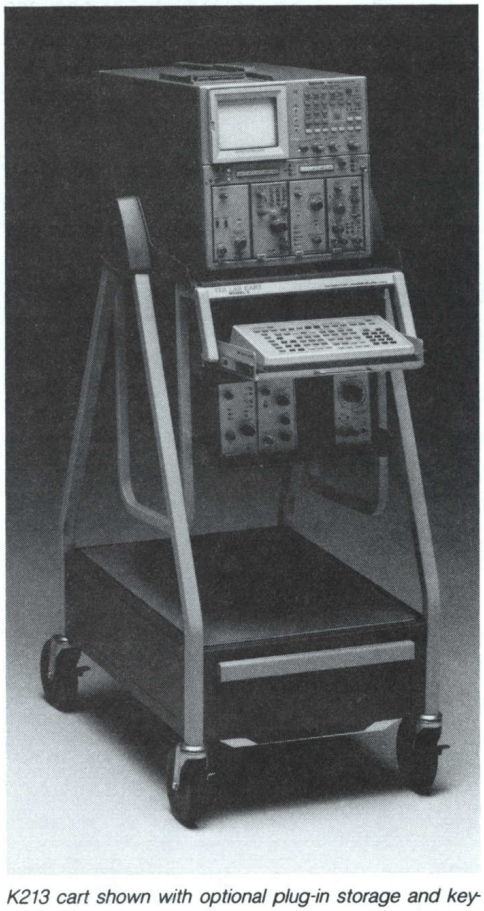
**Power Supply** — To Light Plug-in Pushbuttons. Order 040-0686-01 **$70**

### INTERNATIONAL POWER PLUG OPTIONS (7613/R7613)

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES (7613/R7613)

**Recommended Plug-ins** — See page 190.
**Recommended Probes** — See pages 191 and 426.
**Recommended Cameras** — See pages 192 and 406.
**Recommended Carts** —
K213 Opt 12 — (7613) See page 424.
K217 — (R7613) See page 424.



*K213 cart shown with optional plug-in storage and keyboard drawer.*

# 7000 SERIES PLUG-INS

## CONTENTS

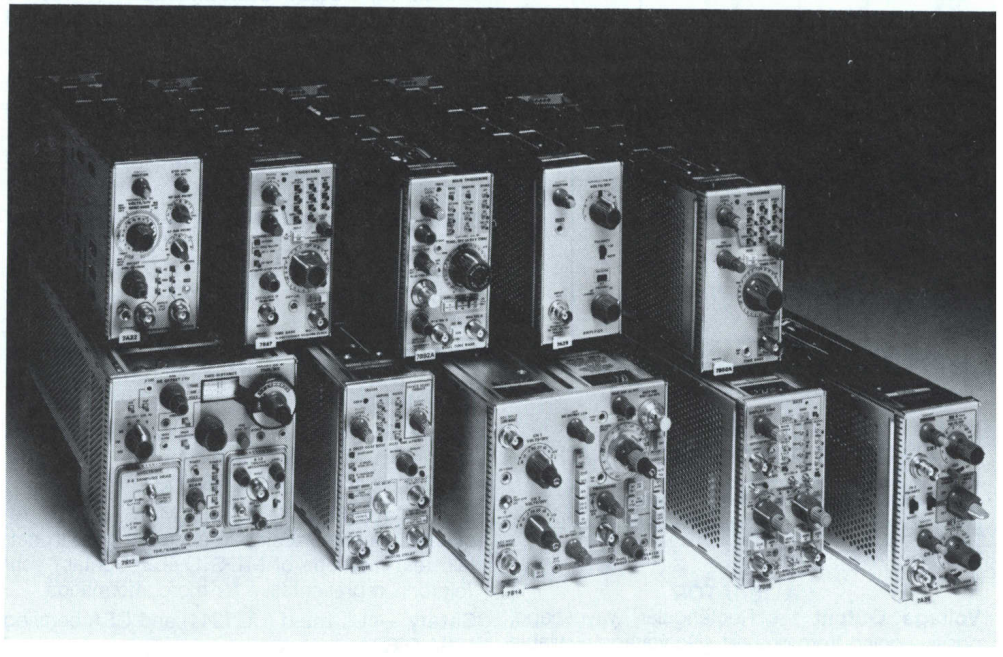

Amplifiers
- Wideband Single Channel ..... 213
- Programmable Digitizer ..... 214, 315
- Dual Trace ..... 215
- Logic Triggered ..... 216
- Differential ..... 218
- Curve Tracer ..... 219

Time Bases
- Delayed ..... 220, 223
- ΔDelaying ..... 220, 223
- Single ..... 220, 224
- Dual ..... 223, 224

Digital
- Multimeter ..... 225
- Delay ..... 226
- A/D Converter ..... 227
- Universal Counter/Timer ..... 228

Spectrum Analyzers ..... 154, 229

Sampling ..... 230

For the 7000 Series, you can select from over forty different plug-in units—single-trace and dual-trace amplifiers, differential comparators, samplers, logic analyzers, spectrum analyzers, trigger recognizers, waveform digitizer, curve tracer, universal counter/timer, digital multimeter, digital delay unit, a wide range of time-bases, and others. This variety lets you tailor your instrument to meet your immediate need—for the most exotic application—and then expand its capabilities later as your needs change.

**Tektronix offers service training classes on various 7000 Series plug-ins. For further training information, contact your local sales/service office or request a copy of the Customer Service Training Catalog on the return card in the back of this catalog.**

# 7A29

**Dc to 1 GHz Bandwidth**

**10 mV/div to 1 V/div Calibrated Deflection Factors**

**50 Ω Input**

**±500 ps Variable Delay Line (Option 04)**

The 7A29 is a high-performance, wide-band, single-trace amplifier which provides a bandwidth of 1 GHz in the 7100 Series mainframes. Bandwidth constant over the entire range of calibrated deflection sensitivities of 10 mV/div to 1 V/div. Input impedance is 50 Ω. Manually resettable input protection circuitry protects the input against most common overloads. Polarity of the display is selectable by a front-panel switch. An optional variable delay line (front-panel adjustable) permits matching the transit time of two 7A29s and/or probes to better than 10 ps.

## CHARACTERISTICS

**Bandwidth** — Dc Coupled: 1 GHz (10 mV/div to 1V/div).

**Deflection Factor** — Calibrated: 10 mV/div to 1 V/div in seven steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated: Variable continuously between steps and a maximum of at least 2.5 V/div (with some bandwidth reduction).

**Input Z** — 50 Ω.

**Ac Coupling** — −3 dB at 1 kHz or less from a 50 Ω source.

**Option 04, Variable Signal Delay** — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is ±500 ps.

**Maximum Input Voltage** — Dc Coupled: 50 V or 10 V RMS (whichever is less). Ac Coupled: 100 V additional.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 0.04 div/°C or less.

**Input Protection** — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated and has manual reset.

## ORDERING INFORMATION

**7A29** Amplifier **$3,245**

**Includes:** Instruction manual (070-2320-00).

**Option 04** — Variable Signal Delay. **+$435**

# P6201 FET Probe

**Dc to 900 MHz Bandwidth**

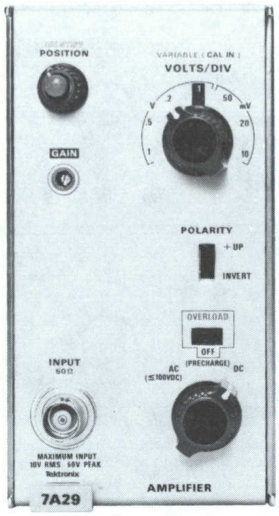
**50 Ω or 1 MΩ Inputs**

Very low input capacitance permits high frequency signal acquisition with minimum loading while high input resistance minimizes low frequency and dc loading. Requires probe power (either from scope or 1101A Probe Power Supply.

## ORDERING INFORMATION

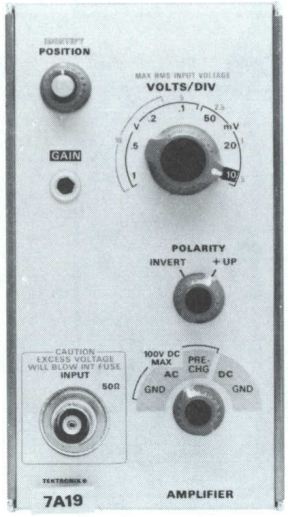
**P6201** 1X, FET Probe.
Order 010-6201-01 **$1,220**

**7A29**



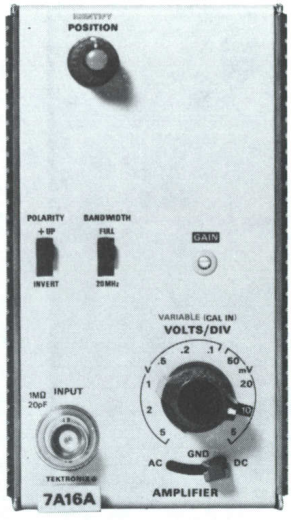

**Dc to 1 GHz Amplifier**

**7A19**




**Dc to 600 MHz Amplifier**

**7A16A**




**Dc to 225 MHz Amplifier**

# 7A19

**Dc to 600 MHz Bandwidth**

**10 mV/div to 1 V/div Calibrated Deflection Factors**

**50 Ω Input**

**±500 ps Variable Delay Line (Option 04)**

The 7A19 is a high-performance, wide-band, single-trace amplifier which provides a bandwidth of 600 MHz in the 7100 Series mainframes. Bandwidth is constant over the entire range of calibrated deflection sensitivities of 10 mV/div to 1 V/div. Input impedance is 50 Ω. An optional variable delay line (front-panel adjustable) permits matching the transit time of two 7A19s and/or probes to better than 50 ps.

## CHARACTERISTICS

**Bandwidth** — Dc Coupled: 600 MHz (10 mV/div to 1 V/div).

**Deflection Factor** — Calibrated: 10 mV/div to 1 V/div in seven steps (1-2-5 sequence). Accuracy is within 3%.

**Input Z** — 50 Ω.

**Option 04, Variable Signal Delay** — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

**Maximum Input Voltage** — Dc Coupled: 50 V or 10 V RMS (whichever is less). Ac Coupled: 100 V additional.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 100 μV/°C or less.

## ORDERING INFORMATION

**7A19** Amplifier **$2,825**

**Includes:** Instruction manual (070-2199-00).

**Option 04** — Variable Signal Delay. **+$435**

# 7A16A

**Dc to 225 MHz Bandwidth**

**5 mV/div to 5 V/div Calibrated Deflection Factors**

**1 MΩ Input**

The 7A16A is a single-trace amplifier which provides a bandwidth of 225 MHz in the 7900 and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications.

## CHARACTERISTICS

**Bandwidth** — Dc Coupled: 5 mV/div to 5 V/div; 250 MHz. Ac Coupled: 10 Hz or less to 250 MHz..

**Deflection Factor** — Calibrated: 5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable continuously between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

**Displayed Noise** — ≤ 0.1 div at 5 mV/div (with a 7900 Series mainframe).

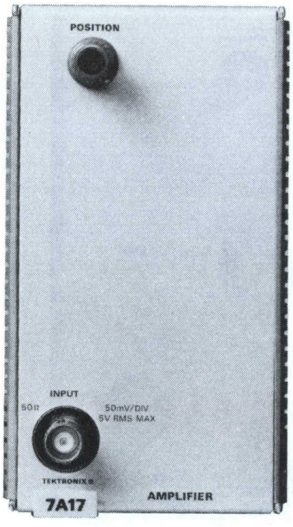
## ORDERING INFORMATION

**7A16A** Amplifier **$1,275**

**Includes:** Instruction manual (070-1378-01).

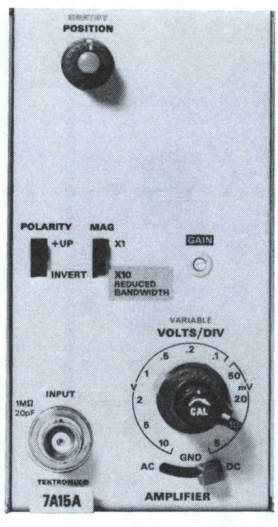
For recommended probes see pages 191 and 426.
For 7000 Series vertical system specifications see page 190.

7A17



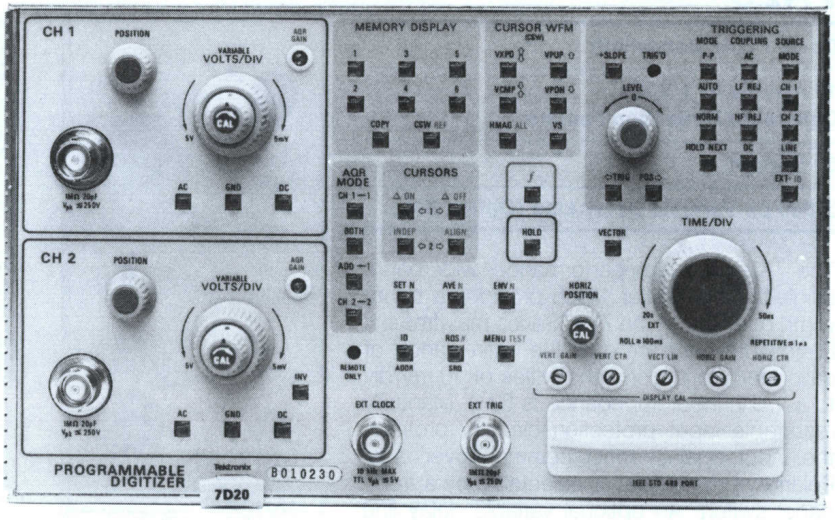

Dc to 150 MHz Amplifier

7A15A




Dc to 80 MHz Amplifier

7D20




Programmable Digitizer

## 7A17

**Dc to 150 MHz Bandwidth**

**50 mV/div Calibrated Deflection Factor**

**Low Cost**

**Easy to Customize**

The 7A17 is a basic, 150 MHz single-channel amplifier with provision for the addition of user-developed circuitry for special unique applications.

The layout of the circuit board assembly provides a blank soldering pad matrix and ground plane surface totaling approximately 40 square inches. Circuits may be installed here. Mainframe power is identified and available on the circuit board. The front subpanel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

### CHARACTERISTICS

**Deflection Factor** — Adjustable to 50 mV/div. There is no step attenuation.

**Input Z** — 50 Ω.

**Maximum Input Voltage** — 5 V RMS.

### ORDERING INFORMATION

**7A17** Amplifier **$455**

**Includes:** Instruction manual (070-1263-00).

## 7A15A

**Dc to 80 MHz Bandwidth**

**5 mV/div to 10 V/div Calibrated Deflection Factors**

**1 MΩ Input**

**500 μV/div at 10 MHz (10X Gain)**

The 7A15A is a single-trace amplifier which provides a bandwidth of 80 MHz in the 7800, 7900, and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 10 V/div. A 10X gain amplifier provides 500 μV sensitivity with a bandwidth of 10 MHz. Polarity of the display is selectable by a front-panel switch.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: 80 MHz (5 mV/div to 10 V/div). Ac coupled: 10 Hz or less to 80 MHz.

**Deflection Factor** — Calibrated: 5 mV/div to 10 V/div in 11 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. X10 mag (increases sensitivity to 500 μV) accuracy is within 10% at 10 MHz bandwidth throughout deflection factor settings. Uncalibrated: Variable continuously between steps to a maximum of at least 25 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 0.01 div/C°. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

### ORDERING INFORMATION

**7A15A** Amplifier **$695**

**Includes:** Instruction manual (070-1210-00).

**For floating measurements, order A6902B Isolator. See page 437 for complete description.**

## 7D20

GPIB IEEE-488

The 7D20 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Digital Storage for 7000 Series Mainframe**

**Totally Programmable**

**70 MHz Bandwidth for Repetitive Signals**

**10 MHz Single-Shot Bandwidth**

**Two Channels Simultaneous Acquisition**

**Pretrigger and Posttrigger**

**Storage of Six Independent Waveforms**

**Enveloping and Signal Averaging**

**Cursor Measurements**

The 7D20 brings state-of-the-art digital performance to Tektronix 7000 Series mainframes and rackmounts. See page 315 for complete description. (Not recommended for use in the 7104 and R7103 mainframes).

### ORDERING INFORMATION

**7D20** Programmable Digitizer **$7,265**

**RECOMMENDED PROBE**

**P6053B Miniature 10X Probe** — Has a probe identification button which allows remote sequencing.

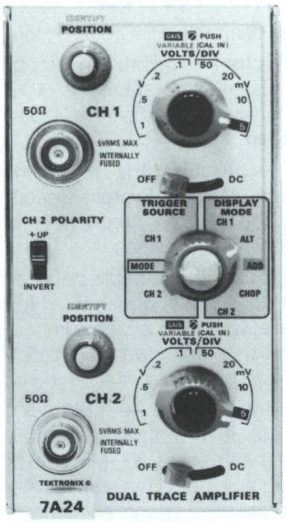
**3.5 Foot Cable** — Order 010-6053-11 **$170**

**6.0 Foot Cable** — Order 010-6053-13 **$170**

**9.0 Foot Cable** — Order 010-6053-15 **$170**

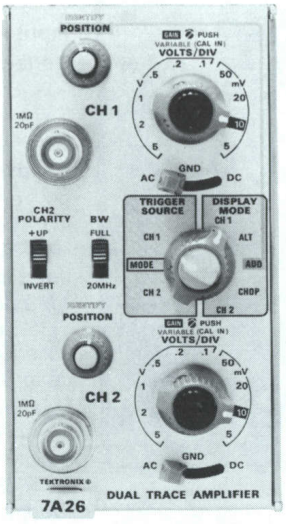
For recommended probes refer to pages 191 and 426.
For 7000 Series vertical system specifications see page 190.

7A24



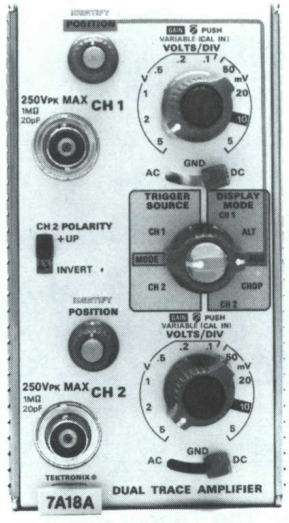

Dc to 400 MHz Amplifier

7A26




Dc to 200 MHz Amplifier

7A18A




Dc to 75 MHz Amplifier

# 7A24

## Dc to 400 MHz Bandwidth

## 5 mV/div to 1 V/div Calibrated Deflection Factors

## 50 Ω Input

The 7A24 is a high-performance, wide-band, dual-trace amplifier which provides 400 MHz bandwidth in the 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities from 5 mV/div to 1 V/div. Input impedance is 50 Ω. The 7A24 features five operating modes, trigger source selectability and trace identify.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: 400 MHz (5 mV/div to 1 V/div).

**Deflection Factor** — Calibrated: 5 mV/div to 1 V/div in eight steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 5 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 2.5 V/div.

**Input Z** — 50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

**Maximum Input Voltage** — Dc Coupled: 5 V RMS.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

**Displayed Noise** — 0.7 div or less at 5 mV/div (with a 7900 Series mainframe).

**Common-Mode Rejection Ratio** — At least 10:1, dc to 50 MHz.

### ORDERING INFORMATION

**7A24** Amplifer — **$2,590**

**Includes:** Instruction manual (070-1485-00).

# 7A26

## Dc to 200 MHz Bandwidth

## 5 mV/div to 5 V/div Calibrated Deflection Factors

## 1 MΩ Input

The 7A26 is a dual-trace amplifier which provides a bandwidth of 200 MHz in the 7900 and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. Bandwidth may be limited to 20 MHz to reduce displayed noise in lower-frequency applications. The 7A26 features five operating modes, trigger source selectability and trace-identify.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: 200 MHz (5 mV/div to 5 V/div). Ac Coupled: 10 Hz or less to 200 MHz (5 mV/div to 5 V/div).

**Deflection Factor** — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 0.02 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 division in any one minute after one hour warm-up.

**Displayed Noise** — 0.1 div or less at 5 mV/div (with a 7900 Series mainframe).

**Common-Mode Rejection Ratio (Add, CH 2 Invert)** — At least 10:1, dc to 50 MHz.

### ORDERING INFORMATION

**7A26** Amplifier — **$2,295**

**Includes:** Instruction manual (070-1484-01).

For recommended Probes see pages 191 and 426.
For 7000 Series vertical system specifications see page 190.

# 7A18A

## Dc to 75 MHz Bandwidth

## 5 mV/div to 5 V/div Calibrated Deflection Factors

## 1 MΩ Input

## Dc Offset (Option 06)

The 7A18A is a dual-trace amplifier which provides a bandwidth of 75 MHz in the 7800, 7900 and 7100 Series mainframes. Bandwidth is constant over the entire range of deflection sensitivities of 5 mV/div to 5 V/div. The 7A18A features five operating modes, trigger source selectability, and a trace-identify function.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: 75 MHz (5 mV/div to 5 V/div). Ac Coupled: 10 Hz or less to 75 MHz (5 mV/div to 5 V/div).

**Deflection Factor** — Calibrated: 5 mV/div to 5 V/div in ten steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 10 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 0.01 div/°C. Drift with Time (Ambient Temperature and Line Voltage Constant): 0.02 div in any one minute after one hour warm-up.

**Displayed Noise** — 0.06 div or less.

**Common-Mode Rejection Ratio (Add, CH 2 Invert)** — At least 10:1, dc to 50 MHz.

### DC OFFSET OPTION

**Option 06, Dc Offset** — Allows small signals riding on larger signals, such as power supply ripple, to be analyzed. Separate Channel 1 and Channel 2 variable offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18A. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

**Offset Range Display** — ±200 division maximum, equivalent to ±1 V at 5 mV/div.

**Accuracy** — When in dc Offset the deflection accuracy is derated by 1%.

### ORDERING INFORMATION

**7A18A** Amplifier — **$1,395**

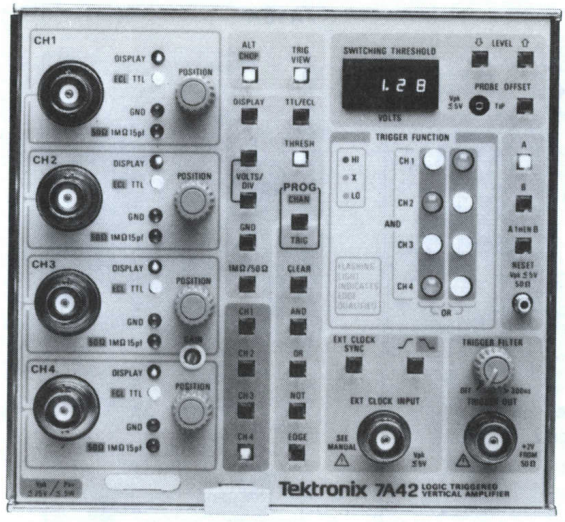
**Includes:** Instruction manual (070-4329-00).

**Option 06** — Dc Offset. — **+$210**

**For floating measurements, order A6902B Isolator. See page 437 for complete description.**

# 7A42

- Up to 350 MHz Bandwidth (7100 Family)
- Four Input Channels
- Boolean Logic Triggering
- Nested Trigger Functions
- Variable Switching Thresholds
- Precise Amplitude and Timing Measurement
- External Clock Synchronization
- 1 MΩ/50 Ω Switchable Inputs
- Variable/Bias Offset Probe Compatibility
- 7000 Series Mainframe Compatible




The 7A42 Four Channel Logic Triggered Vertical Amplifier is a two-wide 7000 Series plug-in that provides a significant new dimension to oscilloscope measurements through the combination of amplifier and triggering technologies. The 7A42 triggering permits all signals to be displayed in analog form for high resolution measurements of both time and amplitude characteristics.

### High Resolution Analog Display of Digital Signals

Very accurate analog representations of digital signals are displayed. Input attenuators can be optimized for either TTL or ECL logic families. A 1 ns risetime with 200 ps or less delay difference between the four input channels provides precise, high resolution timing measurements. The 7A42 accurately displays risetimes and falltimes, allows pulse width to be precisely measured, enables pulse aberrations to be viewed and quantified, and amplitude to be measured with confidence.

### Advanced Triggering

Triggers are generated by the 7A42 upon recognition of user-programmed Boolean combinations of logic levels and transitions at any or all of its input channels. Independent variable switching thresholds and edge sensitivity make triggering on digital signals an easy task.

### Nested Triggering Functions

One level of nested triggering is implemented in the 7A42. Triggers may be generated on event "A", event "B", or on "A then B". In "A then B" mode, the 7A42 arms on event A, and generates a trigger to a time base on the next occurrence of event B. A reset input disarms the 7A42 in nested triggering mode at any time. Nested triggering provides the flexibility needed to trigger on even the most complex event.

### See The Trigger Event

Delay lines in the 7A42 permit the trigger event to be displayed in its entirety. A representation of the 7A42 Trigger Out signal can be displayed on the mainframe CRT. This Trigger View trace shows where the trigger event occurred and how long it lasted.

### Trigger Filtering Prevents Inadvertent Triggering

A continuously variable (equal to or greater than 300 ns) trigger filter control eliminates unnecessary or inadvertent triggering by requiring that a trigger function remain true longer than the Trigger Filter setting.

### External Clock Synchronization

An external clock input allows further qualification of a triggering event to coincide with either a positive or negative transition of an external clock signal. This input is compatible with either TTL or ECL levels.

### Special Probe Features

The 7A42 Probe Offset accommodates the P6230 Variable Bias/Offset Probe, which is ideal for probing ECL circuits with reduced loading. The P6230 is a 1.5 GHz, 450 Ω probe with the ability to place bias voltage at its tip. A wide variety of accessories, including very flexible grounding schemes, make the P6230 ideal for high speed digital circuit testing. The P6131 10X high impedance probe is the recommended probe for TTL, high speed TTL, CMOS and other high impedance logic families.

### Easy Setup

CRT readout of attenuator settings and the display of error messages designed to guide a user through the process of setting up the instrument make the 7A42 easy to operate. The use of multicolored LEDs communicate the status of other 7A42 functions at a glance. A battery backup system preserves the current settings when power is removed and reapplied, thus saving setup time.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Input** — Four channels, BNC connectors.

**Deflection Factor** — Calibrated Through 10X Probe: TTL (CMOS) family is 1, 2, 5 V/div. ECL family is 0.2, 0.5, 1 V/div. Gain Accuracy: Within 3%.

**Bandwidth** — To 350 MHz maximum. See 7000 Series Vertical System Specifications on page 190 for frequency response in specific mainframes.

**Input Impedance** — Selectable between 1 MΩ and 50 Ω. High Impedance: 1 MΩ ±1%, in parallel with ≈15 pF. Low Impedance: 50 Ω ±1 Ω at dc. Vswr is ≤1.15:1, dc to 300 MHz.

**Maximum Input Voltage** — 1 MΩ: 25 V (dc + peak ac) 36 MHz or less, derated linearly to 3 V (peak ac) at 300 MHz. 50 Ω: 5 V RMS during any 1 ms time interval. Active internal protection opens all inputs if overvoltage is applied to any channel.

**Dc Stability** — Drift with Time (Ambient Temperature and Line Voltage Constant): Not more than 0.2 division in any 10 minute after 20 minute warm-up. Drift with Ambient Temperature (Line Voltage Constant): Not more than 0.2 div for 10°C ambient change.

**Differential Delay** — 200 ps maximum between the four input channels.

**Trigger View or External Clock View** — Time Coincidence with Channel Display: Trigger View is within 3 ns. External Clock View is within 5 ns.

### TRIGGER SYSTEM

**Switching Threshold** — Voltage Range*[1]: TTL (CMOS) family is +12.8 V to −12.7 V. ECL family is +2.56 V to −2.54 V. Accuracy*[1]: TTL (CMOS) family is ±50 mV ±2% of setting. ECL family is ±10 mV ±2% of setting.
Presets*[1]: TTL (CMOS) is +1.4 V. ECL is −1.3 V. Probe Offset activated is 0 V.

**Tip (Probe Offset) Input** — Maximum Voltage Range: +5.1 V to −5.1 V, dc only. DVM Accuracy: ±20 mV ±2% of reading.

**Trigger Filter** — Range: Off, or adjustable from <15 ns to >300 ns. Match, Trigger Function A to Trigger Function B: Within 20% at maximum setting.

**External Clock Input** — Maximum Voltage Range: +5 V to −5 V (dc + peak ac). Threshold: Two External Clock Input modes are available, TTL or ECL. TTL level at logic zero is ≤0.8 V; at logic one is ≥2 V. ECL level at logic zero is ≤−1.5 V; at logic one is ≥−1.1 V. Input Impedance: TTL level is ≈10 KΩ in parallel with ≈55 pF, terminated to +5 V, compatible with a 1X probe. ECL level is ≈50 Ω, terminated to −2 V. Pulse Width: TTL level is 20 ns minimum, either pulse transition selected. ECL level is 5 ns minimum, leading pulse transition selected; or 10 ns minimum, trailing pulse transition selected. Setup Time: 10 ns minimum. Hold Time: 10 ns minimum.

**Channel Edge Sensitivity** — Setup Time, Channel to Channel: 5 ns minimum (time that level sensitive portion of trigger function must be true before Edge Sensitive Channel transition).

*[1] *At tip of 10X probe with readout compensation.*

Hold Time, Channel to Channel: 5 ns minimum, (time that level sensitive portion of trigger function must remain true after Edge Sensitive Channel transition). Setup Time, Edge Sensitive Channel: 10 ns minimum (time that level of Edge sensitive channel must be stable before transition). Hold Time, Edge Sensitive Channel: 5 ns minimum (time that level of Edge Sensitive Channel must remain stable after transition).

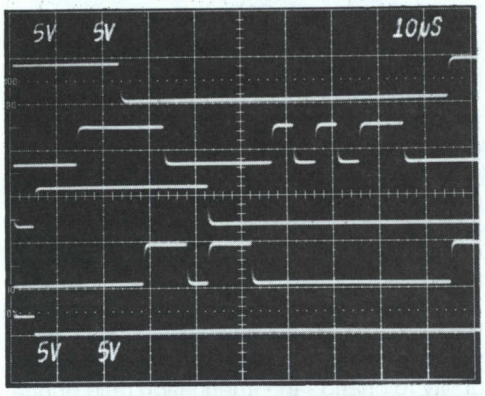
**Trigger Out Connector —** Output Voltage: 1 V into 50 Ω. Output Impedance: ≈50 Ω. Toggle Frequency: 125 MHz maximum. Propagation Delay: Channel Input to Trigger Output is 25 ns or less. A then B Mode: Time between A and B is 5 ns minimum (minimum setup time from event A to event B). Time from B to A is 5 ns minimum (minimum time after event B to next event A). Event Duration (minimum time to insure proper arming and triggering): Event A is 5 ns minimum. Event B is 5 ns minimum. Front panel A then B Gate Output: Active only if selected and in the A then B mode.

**Mainframe A Then B Gate Output —** Active only in A then B mode. Pulse Width (Measured at the 50% Points): Greater than the time between event A and event B by 5 ns ±2 ns.

**Reset Input —** Maximum Input Voltage: +5 V to −5 V (dc + peak ac). Input Impedance: ≈50 Ω. Logic Zero Level: ≤0.2 V. Logic One Level: ≥0.8 V. Pulse Width: 100 ns minimum. Timing (Post-Reset Inhibit Time to Next Trigger): 10 ns minimum (time from falling edge of Reset to next recognizable event).

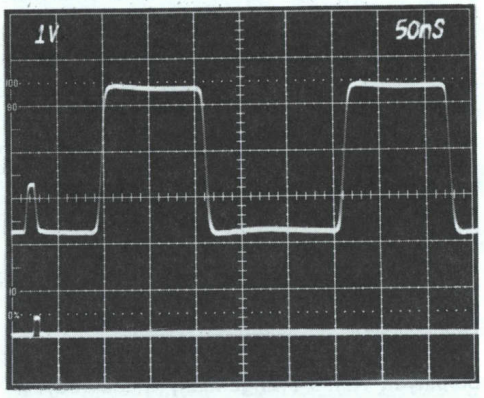
Response Time: Reset pulse must lead or be coincident with event recognition to inhibit trigger output. Event recognition must lead the Reset pulse by 10 ns to guarantee trigger output.

### Four Channel Analog Display with Trigger View



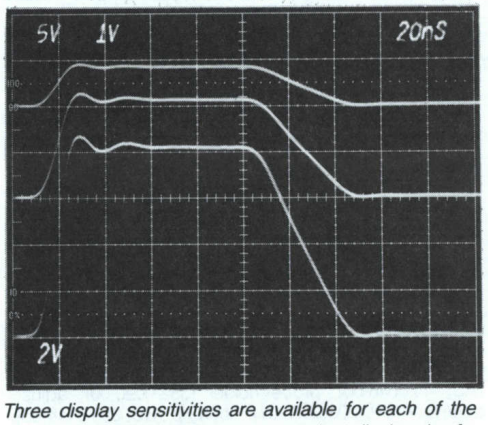

*Up to four logic signals can be displayed by the 7A42 in true analog form. Additionally, the Trigger View trace provides the ability to view exactly when the programmed Trigger Function is satisfied.*

### Selective Triggering on a Low Amplitude Pulse



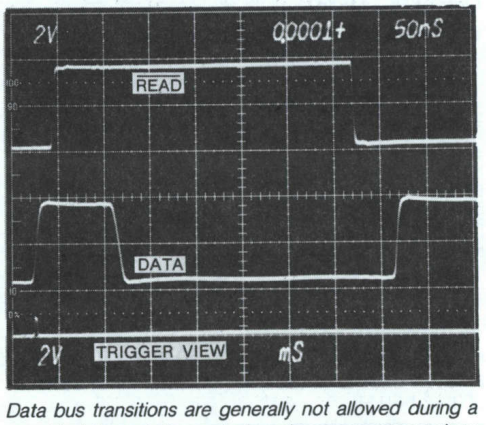

*Independent and variable trigger thresholds for each of the four input channels allow selective triggering on an abnormally low amplitude pulse (indeterminate state) within a pulse train. Shown above, two channels are used to establish dual thresholds to bracket the low level pulse. The 7A42 triggers on any signal that remains between the two thresholds longer than the time set by the Trigger Filter.*

### Range of Sensitivities




*Three display sensitivities are available for each of the logic families. Select the most convenient display size for the application; small amplitudes for many traces on the screen, or large sizes when more signal detail is desired.*

### Edge Sensitive Triggering




*Data bus transitions are generally not allowed during a specified time at the end of a microprocessor read cycle. In the above display, the 7A42 has captured a positive transition of a data line during the time when data should have been stable (note trigger view pulse). The 7A42's Edge Sensitivity enhances its Boolean triggering by detecting rising or falling transitions of one signal during a time qualified by the states of the other channels.*

For recommended probes see pages 191 and 426.
For 7000 Series vertical system specifications see page 190.

### BATTERY BACKUP

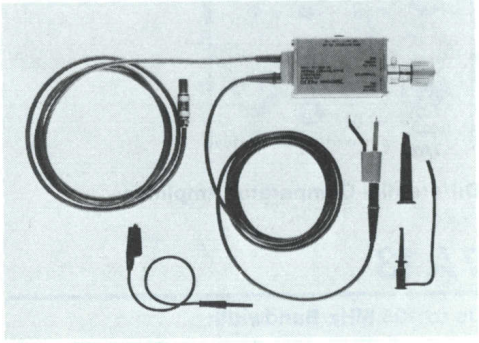
**Ni-Cad Battery (3.75 V) —** Provides power to preserve front panel control status a minimum of 200 hours while main power is off. Battery requires about 24 hours to fully charge from discharged condition.

## ORDERING INFORMATION

**7A42** Logic Triggered Vertical Amplifier **$6,050**
**Includes:** Instruction manual (070-4285-00).

### OPTIONAL ACCESSORIES

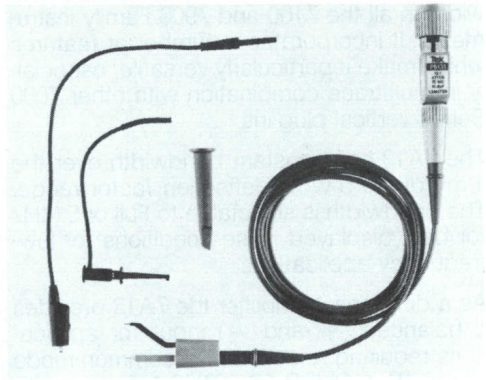
**P6230 Variable Bias/Offset 10X Probe**



*The P6230 probe is recommended for high speed ECL probing. It is a very low capacitance, high bandwidth, probe ideal for ECL and features a variable bias/offset that minimizes its dc loading on the circuit. See page 434 for details.*

Order 010-6230-01 **$395**

**P6131 10X Passive Probe**

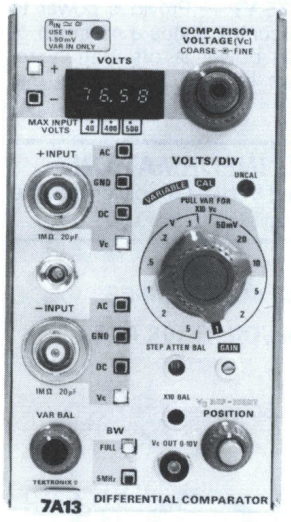


*The P6131 is a general purpose probe, ideal for use with TTL and CMOS circuits, and is recommended for use with the 7A42 for up to 300 MHz system bandwidth. Several subminiature and miniature accessories are also available including a probe-to-DIP for IC testing. See page 433 for details.*

Order 010-6131-01 **$140**

**KLIPKIT —** Provides hands-free connection to integrated circuits. See page 433 for complete description. Order 013-0197-00 **$40**

7A13




**Differential Comparator Amplifier**

# 7A13

**Dc to 105 MHz Bandwidth**

**1 mV/div to 5 V/div Calibrated Deflection Factors**

**1 MΩ Input Switchable to ∞**

**20,000:1 CMRR**

**10,000 cm Effective Screen Height**

The 7A13 is a differential comparator amplifier which provides dc to 105 MHz bandwidth in all the 7100 and 7900 Family instruments. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to Full or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and −) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 provides an accurate (0.1%) positive or negative internal offsetting voltage of up to ±10 V. This precision offset voltage effectively provides a screen height of 10,000 div at 1 mV/div. The offset voltage is also available as an output for external monitoring.

## CHARACTERISTICS

**Bandwidth** — Dc Coupled: 105 MHz (1 mV/div to 5 V/div).

**Input R and C** — 1 MΩ within 0.15%; ≈20 pF. Rin ≈∞ is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 12.5 V/div.

**Maximum Input Gate Current** — 0°C to +35°C: 0.2 nA or less. +35°C to +50°C: 2 nA or less.

**Dc Stability** — Drift with Ambient Temperature (Line Voltage Constant): 2 mV/10°C to 0.2 div/10°C or less, (whichever is greater). Drift with Time (Ambient Temperature and Line Voltage Constant): Short term is 1 mV p-p or 0.1 div or less (whichever is greater) over any one minute interval after 20 minute warm-up. Long term is 1 mV p-p or 0.1 division or less (whichever is greater) during any one hour interval after 20 minute warm-up.

**Signal Range**

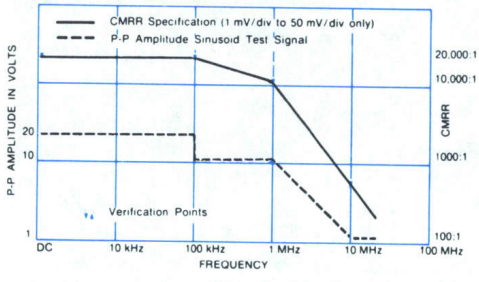
| Deflection Factor Settings | 1 mV to 50 mV/div | 10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div | 0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div |
|---|---|---|---|
| Common-mode Signal | ±10 V | ±100 V | ±500 V |
| Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less) | ±40 V | ±400 V | ±500 V |
| Maximum Ac Coupled Input (dc voltage) | | ±500 V | |

**Displayed Noise (Tangentially Measured)** — With X10 Vc In: 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc Out: 0.4 div or less at 10 mV/div to 0.5 V/div.

**Overdrive Recovery** — 1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only, regardless of pulse duration.

**Internal Comparison Voltage** — Range: 0 V to ±10 V. Accuracy: ±(0.1% of setting +3 mV). Vc Output R: ≈15 kΩ.

**Common-Mode Rejection Ratio**




At least 2000:1, 10 mV/div to 50 mV (X10 Vc out) and 0.1 V/div to 5 V/div. Ac coupled input at least 500:1 at 60 Hz.

## ORDERING INFORMATION

**7A13** Amplifier **$3,320**

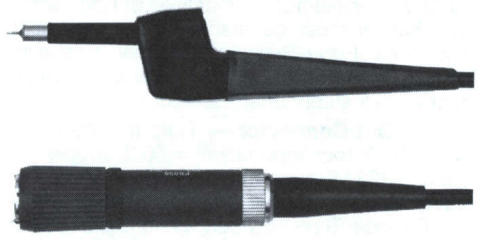
**Includes:** Instruction manual (070-1940-02).

**For floating measurements, order A6902B Isolator. See page 437 for complete description.**

For recommended probes see pages 191 and 426.
For 7000 Series vertical system specifications see page 190.

# P6055

**20,000:1 CMRR 10X with Readout**



**Dc to 60 MHz**

**Low Capacitance**

**High CMRR**

**Compact Size**

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provides the best possible system CMRR.

## CHARACTERISTICS

**Maximum Useful Bandwidth** — 60 MHz.

**Risetime** — 5.8 ns.

**Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

**Attenuation** — Adjustable to 10X.

**Input Resistance** — 1 MΩ ±0.5%.

**CMRR** — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

**Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

## ORDERING INFORMATION

**P6055** 10X, 3.5 ft, Differential Probe.
Order 010-6055-01 **$275**

**Includes:** Retractable hook tip (BB, 013-0107-05); 13 cm (5 inch) ground lead (175-0124-01); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); probe holder (352-0090-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual (070-1115-00).

**Matched Pair** of P6055 Probes.
Order 015-0437-00 **$535**

**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext 99.**

# 7A22

**Dc to 1 MHz Bandwidth**

**10 μV/div to 10 V/div Calibrated Deflection Factors**

**1 MΩ Input**

**100,000:1 CMRR**

**Selectable Upper and Lower −3 dB Points**

**Dc Offset**

**10 μV/Hour Dc Drift*[1]**

The 7A22 is a high-gain differential amplifier well suited for difficult low-amplitude, low-frequency measurements. Selectable high and low pass filters help eliminate unwanted noise and drift from the display and from the triggering signal.

## CHARACTERISTICS

**Bandwidth —** HF: −3 dB point. Selectable in nine steps (1-3 sequence) from 100 Hz to 1 MHz. Accuracy is within 10% of selected frequency. Risetime is 350 ns ±9% in 1 MHz position. LF: −3 dB point. Selectable in six steps (1-10 sequence) from 0.1 Hz to 10 kHz. Accuracy is within 12% of selected frequency. The switch also contains dc and dc with Offset positions. Ac coupled at input, 2 Hz or less.

**Deflection Factor —** Calibrated: 10 μV/div to 10 V/div in 19 steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 1 mV/div. Uncalibrated: Variable continuously between steps to a maximum of at least 25 V/div.

**Signal and Offset Range**

| Deflection Factor Settings | 10 μV to 10 mV/div | 20 mV to 0.1 V/div | 0.2 V to 1 V/div | 2 V to 10 V/div |
|---|---|---|---|---|
| Common-Mode Signal | ±10 V | ±100 V | ±500 V | |
| Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less) | ±15 V | ±200 V | ±500 V | |
| Maximum Ac Coupled Input (dc voltage) | ±500 V dc rejection, at least 4 x $10^5$:1 | | | |
| Dc Offset | +1 V to −1 V | +10 V to −10 V | +100 V to −100 V | +1000 V to −1000 V |

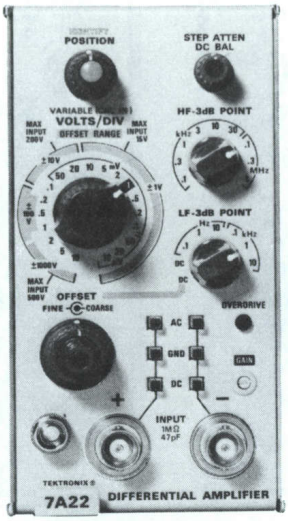
**Input R and C —** 1 MΩ within 1%; ≈47 pF.

**Maximum Input Gate Current (Differentially Measured) —** 10 μV/div to 10 mV/div: 40 pA at +25°C; 200 pA at +50°C. 20 mV/div to 10 V/div: 10 pA: 10 pA at +25°C; 20 pA at +50°C.

Single ended, one-half the differential measurement. Display shift (10 μV/div, ac coupled) is ±4 division at +25°C; ±20 division at +50°C.

*[1] *With constant temperature. See dc stability specifications.*

7A22



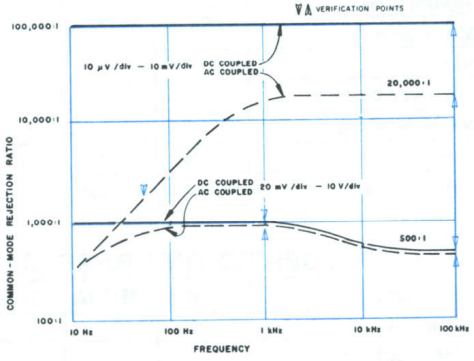

**Differential Amplifier**

**Dc Stability —** (Line Voltage Constant): 50 μV/°C or less. Drift with Time (Ambient Temperature and Line Voltage Constant): Short term is 5 μV p-p or 0.1 div (whichever is greater) over any one minute interval after one hour warm-up. Long term is 10 μVp-p or 0.1 div (whichever is greater) in any one hour interval after one hour warm-up.

**Displayed Noise —** 16 μV or 0.1 div (whichever is greater) at maximum bandwidth. Source resistance 25 Ω or less measured tangentially.

**Overdrive Recovery —** 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front-panel Overdrive light indicates that an overdrive condition is being approached.

**Common-Mode Rejection Ratio (for signals not exceeding common-mode signal range)**




## ORDERING INFORMATION

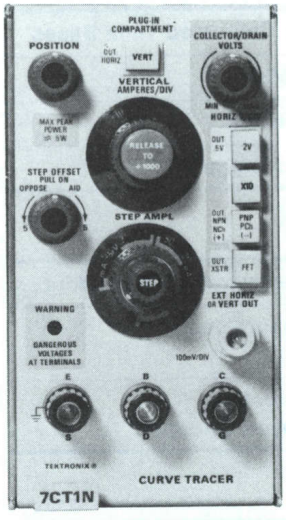
**7A22** Amplifier **$1,745**

**Includes:** Instruction manual (070-0931-00).

High CMRR Differential Probes
Matched pair of P6055 probes for maximum CMRR. (See page 439 for complete P6055 description.) Order 015-0437-00 **$535**

**For recommended probes see pages 191 and 426.**
**For 7000 Series vertical system specifications see page 190.**

7CT1N




**Curve Tracer**

# 7CT1N

**10 nA/div to 20 mA/div Vertical Deflection Factors**

**0.5 V/div to 20 V/div Horizontal Deflection Factors**

The 7CT1N converts your 7000 Series oscilloscope into a semiconductor curve tracer capable of displaying characteristics of small-signal devices to power levels up to 0.5 W. The 7CT1N operates in either the horizontal or vertical compartments of any 7000 Series mainframe. It may be used in conjunction with standard amplifier and time-base plug-in units to display signal waveforms along with characteristic curve families.

**For more information on the 7CT1N see page 402 in Curve Tracer section.**

## ORDERING INFORMATION

**7CT1N** Curve Tracer **$1,740**

**Includes:** Instruction manual (070-1247-00).

# 7B80/7B85/7B87

**1 ns/div to 5 s/div Calibrated Time Bases**

**Triggering to 400 MHz**

**Variable Trigger Holdoff**

**Peak-to-Peak Auto Triggering**

**7B85 Features:**

**ΔTime Measurements with CRT Readout**

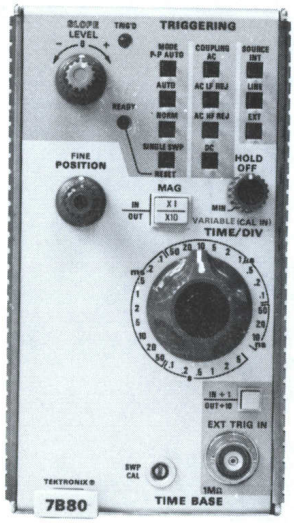
**Delayed Time Measurements with CRT Readout**

**Vertical Trace Separation Between Two Delayed Sweeps**

**7B87 Features:**

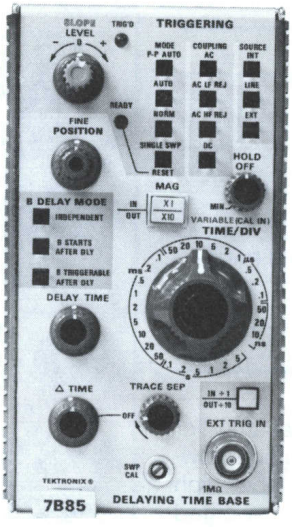
**Pretrigger When Used with 7854**

7B80



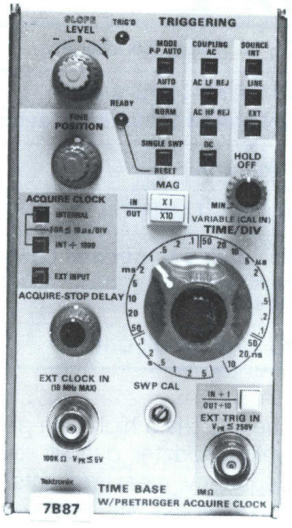

**Delayed Time Base**

7B85




**ΔDelaying Time Base**

7B87




**Time Base**

The 7B80, 7B85 and 7B87 are horizontal time bases recommended for use with 7700, 7800 and 7900 Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Each plug-in can be used separately as an independent single time base, or combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (Display Mode) selects normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system. This option is appropriate where the user is making Y-T and X-Y measurements, and changing the amplifier frequently from the vertical to the horizontal compartment is not acceptable.

The 7B87 is designed for use with the 7854 mainframe to provide additional pretrigger capability. The pretrigger feature is compatible only with the 7854 at this time. When used in the B horizontal of the 7854, the 7B87 provides both single shot and pretrigger capability to the 7854.

Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

The Int ÷ 1000 control reduces the stored time/div to 1000 times slower than the real time display on a 7854. This does not, however, affect the Acquire-Stop delay time. The Int ÷ 1000 control allows stored sweep speeds from 10 ms to 5000 s/div for slow speed applications.

An Ext Clock-In connector is provided for clock frequencies other than that offered by the Int clock of the 7B87.

## 7000 SERIES TIME BASE SELECTION GUIDE

| Performance Feature | 7B50A | 7B53A | 7B80 | 7B85 | 7B87 | 7B92A | 7B10 | 7B15 |
|---|---|---|---|---|---|---|---|---|
| Single Time Base | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Dual Time Base | | ✓ | | | | ✓ | | |
| With Mixed Sweep | | ✓ | | | | | | |
| TV Sync Triggering | | Opt 05 | | | | | | |
| Used Also As Delayed Time Base | | | ✓ | | | | ✓ | |
| Delaying Sweep | | | | ✓ | | | | ✓ |
| ΔDelay Sweep | | | | ✓ | | | | ✓ |
| Pretrigger | | | | | ✓ | | | |
| Single Shot Digitizing | | | | | ✓ | | | |
| Display Switching | | | | | | ✓ | | |
| Page | 224 | 224 | 220 | 220 | 220 | 222 | 223 | 223 |
| Prices Begin At | $1,075 | $1,685 | $1,620 | $1,895 | $1,800 | $3,745 | $2,495 | $2,830 |

## 7000 SERIES TIME BASE/MAINFRAME RECOMMENDATION

| Mainframe | 7B50A | 7B53A | 7B80 | 7B85 | 7B87 | 7B92A | 7B10 | 7B15 |
|---|---|---|---|---|---|---|---|---|
| 7104/R7103 | | | | | | ✓ | ✓ | ✓ |
| 7904A/R7903 | | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 7844/R7844 | | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 7834 | | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 7854 | | | ✓*1 | ✓*1 | ✓ | ✓*1 | ✓*1 | ✓*1 |
| 7704A/R7704 | | | ✓ | ✓*2 | | ✓*2 | ✓ | ✓*2 |
| 7603/R7603 | ✓ | ✓ | | | | | | |
| 7633/R7633 7623A/R7623A | ✓ | ✓ | | | | | | |
| 7613/R7613 | ✓ | ✓ | | | | | | |

*1 *Full capabilities of 7854 not achievable with this time base.*
*2 *No trace separation on R7704.*

## CHARACTERISTICS

Characteristics are common to all three units unless otherwise noted.

### MAIN SWEEP

**Sweep Rates —** Calibrated: 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 1 ns div. Uncalibrated: Variable is continuous to at least 2.5 times the calibrated sweep rate.

**Sweep Accuracy —** Measured over the center eight divisions, +15°C to +35°C, in the 7700, 7800, or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

| Time/Div*1 | Unmagnified | Magnified |
|---|---|---|
| 5 s/div to 1 s/div | 4.0% | Unspecified |
| 0.5 s/div to 50 ns/div | 1.5% | 2.5% |
| 20 ns/div to 10 ns/div | 2.5% | 4.0% |

*1 *Fastest calibrated sweep rate is limited by 7700 and 7600.*

**Trigger Holdoff Time**

| | Minimum | Maximum with Variable |
|---|---|---|
| 5s/div to 1 μs/div | 2 times Time/Div setting or less | 2 times Time/Div setting |
| 0.5 μs/div to 10 ns/div | 2.0 μs or less | 2 times Time/Div setting |
| 20 ms/div or faster | 2 times Time/Div setting | 2 times Time/Div setting |

**ΔTime Range —** (7B85 only) 0 to at least 9.0 times Time/Div setting.

**ΔTime Accuracy (+15°C to +35°C) —** (7B85 only) 0.5 s/div to 50 ms/div: Within (0.5% of reading +0.1% full scale +1 count)*1. 20 ms/div to 100 ns/div: Within (0.5% of reading +0.03% full scale +1 count)*1.

*1 *Full scale equals ten times the Time/Div switch setting.*

**Trace Separation Range —** (7B85 only) Functional only in ΔDelay Time mode when alternating or chopping between time base units. The second delayed sweep display can be vertically positioned at least three divisions below the first delayed sweep display.

**Delay Time Range —** (7B85 only) 0.2 or less to at least 9.0 times Time/Div setting.

**Delay Time Jitter —** (7B85 only) 0.02% or less of Time/Div setting plus 0.1 ns.

### TRIGGERING

**Triggering Sensitivity From Repetitive Signals (Auto and Norm Modes)**

| Coupling | Triggering Frequency Range*1 | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 50 MHz | 0.3 div | 50 mV |
| | 50 MHz to 400MHz | 1.5 div | 250 mV |
| Ac LF Rej*2 | 30 kHz to 50 MHz | 0.3 div | 50 mV |
| | 50 MHz to 400 MHz | 1.5 div | 250 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 50 mV |
| Dc*3 | Dc to 50 MHz | 0.3 div | 50 mV |
| | 50 MHz to 400 MHz | 1.5 div | 250 mV |

*1 *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

*2 *Will not trigger on sinewaves of less than eight division Internal, or 3 V External, at or below 60 Hz.*

*3 *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

**Single Sweep —** Requirements are same as for repetitive signals.

**Internal Trigger Jitter —** 0.1 ns or less at 400 MHz.

**Triggering Sensitivity in P-P Auto Mode**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac or dc | Low Frequency Response: At least 50 Hz | 2.0 div | 500 mV |
| Ac or dc | 200 Hz to 50 MHz | 0.5 div | 125 mV |
| Ac or dc | 50 MHz to 400 MHz | 1.5 div | 375 mV |

**External Trigger Input —** Maximum Input Voltage: 250 V (dc + peak ac). Input R and C: 1 MΩ within 5% and 20 pF within 10%. Level Range (Excluding P-P Auto): At least ±1.5 V in Ext ÷ 1, at least ±15 V in Ext ÷ 10.

**Internal Clock —** (7B87 only) Pretrigger: 0.02048 Hz to 20.45 MHz determined by the Time/Div, X10 magnification and ÷ 1000 switches. Accuracy of Internal and Internal ÷ 1000 = 0.1%.

**External Clock —** (7B87 only) Maximum Input: 5 V peak. Input R: 100 kΩ within 5%. Threshold voltage TTL compatible. Maximum input frequency 10 MHz with BNC input. Delay 0.5 μs or less.

**Acquire Stop Delay —** (7B87 only) Total Range: 0.2 or less to at least 9.9 times Time/Div setting. Jitter (5 s/div to 10 μs/div): 0.02% of Time/Div setting or less. Delay Accuracy (+15°C to +35°C): From 0.5 s/div to 10 μs/div is within 0.5% of measurement plus 5% of Time/Div setting.

**Single Shot Performance —** (7B87 only) With 7854 Internal Clock.

| Fastest Sweep (Time/Div) | Points/Waveform |
|---|---|
| 50 μs | 128 |
| 100 μs | 256 |
| 200 μs | 512 |
| 500 μs | 1024 |

**7B80 Option 02, X-Y Display Capability —** A front panel switch selects either normal sweep displays or X-Y displays. In the X-Y mode, the X and Y signals are applied to the inputs of a dual trace vertical amplifier or two single trace vertical amplifiers. The X signal is routed via the amplifier/mainframe trigger path to the 7B80 Option 02, and then to the mainframe horizontal amplifier for display.

## ORDERING INFORMATION

**7B80** Time Base **$1,620**
**Includes:** Instruction manual (070-1959-00).

**Option 02 —** X-Y Display Capability. **+$105**

**7B85** Delaying Time Base **$1,895**
**Includes:** Instruction manual (070-1961-01).

**7B87** Time Base (for use with 7854) **$1,800**
**Includes:** Instruction manual (070-2788-00).

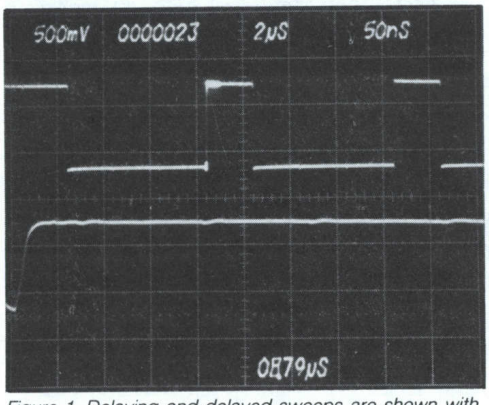



*Figure 1. Delaying and delayed sweeps are shown with the mainframe selecting Alt sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.*

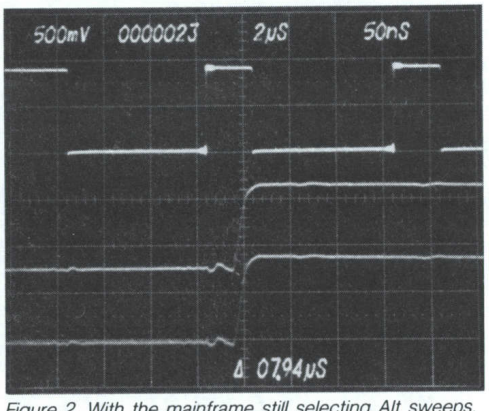
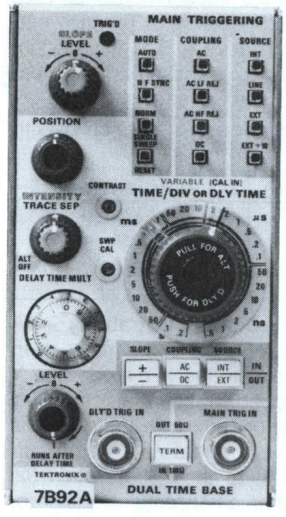



*Figure 2. With the mainframe still selecting Alt sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The Trace Separation knob is used to position the second delayed sweep below the first delayed sweep with up to three division of separation.*

7B92A




**Dual Time Base**

# 7B92A

**0.5 ns/div to 0.2 s/div Calibrated Time Base**

**Triggering to 500 MHz**

**Alternate Display of Intensified Delaying and Delayed Sweeps**

**Contrast Regulation Between Delaying and Delayed Sweeps**

The 7B92A Dual Time Base is recommended for use in the 7100, 7800 and 7900 Series mainframes. (The 7B92A may be used in all other mainframes at slower sweep speeds.)

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep. When operating in the Auto mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

## CHARACTERISTICS

### DELAYING SWEEP (MAIN SWEEP)

**Sweep Rate** — Calibrated: 0.2 s/div to 10 ns/div in 27 steps (1-2-5 sequence). Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between delaying and delayed sweeps.

**Sweep Accuracy** — Measured over the center eight division in a 7900 Series mainframe:

| Time/Div | +15°C to +35°C | 0°C to +50°C |
|---|---|---|
| 0.2 s/div to 20 ns/div | Within 2% | Within 3% |
| 10 ns/div | Within 3% | Within 4% |

**Delay Time Multiplier Range** — 0 to 9.8 times the Delay Time/Div setting from 0.2 s/div to 10 ns/div (0 s to 1.96 s).

**Delay Time Jitter*1**

| | |
|---|---|
| 0.2 s/div to 50 µs/div | 1 part in 50,000 of the maximum available delay time |
| 20 µs/div to 10 ns/div | 1 part in 50,000 of the maximum available delay time +0.5 ns |

*1 *Not applicable for the first 2% of maximum available delay time (Delay Time Mult dial setting >0.2). Maximum available delay time is ten times the Time/Div or Delay Time switch setting.*

**Differential Delay Time Measurement Accuracy*1**
**Sweep Speed**

| | | |
|---|---|---|
| 0.2 s/div to 0.1 µs/div | Both Delay Time Mult dial settings at 0.5 or greater | ±(0.75% of reading +0.25% of full scale*2) |
| | One or both Delay Time Mult dial settings at less than 0.5 | ±(0.75% of reading +0.5% of full scale*2 +5 ns) |
| 50 ns/div to 10 ns/div | Both Delay Times equal to or greater than 25 ns | ±(1% of reading +0.5% of full scale*2) |
| | One or both Delay Times less than 25 ns | ±(1% of reading +1% of full scale*2 +5 ns) |

*1 *+15°C to +35°C.*

*2 *Full scale is ten times the Time/Div or Dly Time setting. Accuracy applies over the center eight division from +15°C to +35°C.*

### TRIGGERING

**Triggering Sensitivity (Auto and Norm Modes)**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 20 MHz | 0.5 div | 100 mV |
| | 20 MHz to 500 MHz | 1.0 div | 500 mV |
| Ac LF Rej | 30 kHz to 20 MHz | 0.5 div | 100 mV |
| | 20 MHz to 500 MHz | 1.0 div | 500 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.5 div | 100 mV |
| Dc to 20 MHz | 0.5 div | 100 mV | |
| Dc | 20 MHz to 500 MHz | 1.0 div | 500 mV |

**HF Sync** — Triggering sensitivity is 0.5 div Int or 100 mV Ext, from 100 MHz to 500 MHz for any coupling except Ac HF Rej.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

**Internal Trigger Jitter** — 50 ps or less at 500 MHz.

**External Trigger Input** — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Input Voltage: 250 V (dc + peak ac) for 1 MΩ input and 1 W average for 50 Ω input. Level Range: At least ±3.5 V in Ext, at least ±35 V in Ext ÷ 10.

### DELAYED SWEEP

**Sweep Rate** — Calibrated: 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between delaying and delayed sweeps.

**Sweep Accuracy** — Measured over the center eight divisions in a 7900 Series mainframe:

| Time/Div | +15°C to +35°C | 0°C to +50°C |
|---|---|---|
| 0.2 s/div to 20 ns/div | Within 2% | Within 3% |
| 10 ns/div to 5 ns/div | Within 3% | Within 4% |
| 2 ns/div to 1 ns/div | Within 4% | Within 5% |
| 0.5 ns/div | Within 5% | Within 6% |

**Delayed Triggering Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 20 MHz | 0.5 div | 100 mV |
| | 20 MHz to 500 MHz | 1.0 div | 500 mV |
| Dc | Dc to 20 MHz | 0.5 div | 100 mV |
| | 20 MHz to 500 MHz | 1.0 div | 500 mV |

**Internal Trigger Jitter** — 50 ps or less at 500 MHz.

**External Trigger Input** — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum Voltage Input: 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Level Range: At least ±3.5 V in Ext.

## ORDERING INFORMATION

**7B92A** Dual Time Base **$3,745**

**Includes:** Instruction manual (070-1751-02).

# 7B10/7B15

**0.2 ns/div to 0.2 s/div Calibrated Time Bases**

**Triggering to 1 GHz**

**Variable Trigger Holdoff**

**Peak-to-Peak Auto Triggering**

**7B15 Features:**

**ΔTime Measurements with CRT Readout**

**Delayed Time Measurements with CRT Readout**

**Vertical Trace Separation Between Two Delayed Sweeps**

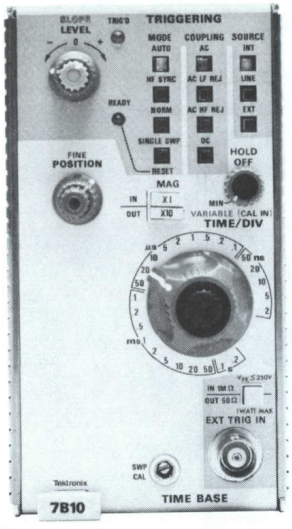
The 7B10 and 7B15 are horizontal time bases designed for use with the 7100 Series mainframes to provide optimum bandwidth/sweep-speed compatibility, but may also be used with the 7700, 7800, and 7900 Series mainframes. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

The 7B10 and 7B15 provide the Δtime measurement in addition to the standard delay time display.

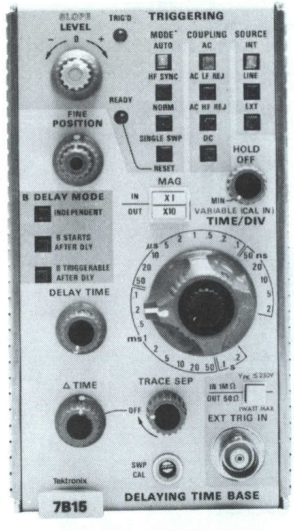
Delta time measurement is accomplished simply by manually positioning two intensified zones on the waveform. The time difference between the two zones is displayed in the CRT readout. (See waveform photos on page 221.) Expansion and overlapping of the two intensified zones is possible to allow very precise setting of the zones to the desired points on the displayed waveform.

**7B10**




**Delayed Time Base**

**7B15**




**ΔDelaying Time Base**

## CHARACTERISTICS

### MAIN SWEEP

**Sweep Rates** — Calibrated: 2 ns/div to 0.2 s/div in 25 steps (1-2-5 sequence). X10 Magnifier extends fastest calibrated sweep rate to 0.2 ns/div. Uncalibrated: Variable is continuous to at least 2.5 times the calibrated sweep.

**Sweep Accuracy** — Measured over the center eight divisions, +15°C to +35°C, in a 7100, 7800 or 7900 Series mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

| Time/Div*1 | Unmagnified | Magnified |
|---|---|---|
| 0.2 s/div to 10 ns/div | 2% | 3% |
| 5 ns/div and 2 ns/div | 3% | 4% |

*1 *Fastest calibrated sweep rate is limited by 7900, 7800, 7700, 7600 and 7300 Series mainframes.*

**Trigger Holdoff Time**

| | Minimum | Maximum with Variable |
|---|---|---|
| 0.2 s/div to 50 ms/div | 40 ms or less | 400 ms or greater |
| 20 ms/div to 2 μs/div | 2 times the Time/Div Setting | 20 times the Time/Div Setting |
| 1 μs/div to 0.5 μs/div | 2 μs or less | 20 μs or greater |
| 0.2 μs/div to 2 ns/div | 2 μs | 6 μs or greater |

**ΔTime Range** — (7B15 only) 0 to at least 9.0 times Time/Div setting.

**ΔTime Accuracy** — 20 ms/div to 100 ns/div. Within 0.5% of reading +3 counts.

**Trace Separation Range** — (7B15 only) Functional only in ΔDelay Time mode when alternating or chopping between time base units. The second delayed sweep display can be vertically positioned at least three divisions below the first delayed sweep display.

**Delay Time Range** — (7B15 only) 0.2 or less to at least 9.0 times Time/Div setting.

**Delay Time Jitter** — (7B15 only) 0.02% of Time/Div setting up through 50 μs/div. 0.03% of Time/Div setting plus 0.1 ns for sweep speeds of 20 μs/div through 100 ns/div.

### TRIGGERING

**Triggering Sensitivity for Repetitive Signals**

| Coupling | Triggering Frequency Range*1 | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 250 MHz | 0.5 div | 50 mV |
| | 250 MHz to 1 GHz | 1.5 div | 150 mV |
| Ac LF Rej*2 | 50 kHz to 250 MHz | 0.5 div | 50 mV |
| | 250 MHz to 1 GHz | 1.5 div | 150 mV |
| Ac HF Rej | 30 Hz to 40 kHz | 0.5 div | 50 mV |
| Dc*3 | Dc to 250 MHz | 0.5 div | 50 mV |
| | 250 MHz to 1 GHz | 1.5 div | 150 mV |

*1 *The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.*

*2 *Will not trigger on sinewaves at or below 60 Hz when amplitudes are less than eight division Internal or 3 V External.*

*3 *The Triggering Frequency Range for Dc Coupling applies to frequencies above 30 Hz when operating in the Auto Triggering Mode.*

**Single Sweep** — Requirements are the same as for repetitive signals.

**Internal Trigger Jitter** — 30 ps or less at 1 GHz.

**HF Sync Mode** — 250 MHz to 1 GHz 0.3 div Internal and 0.75 mV External.

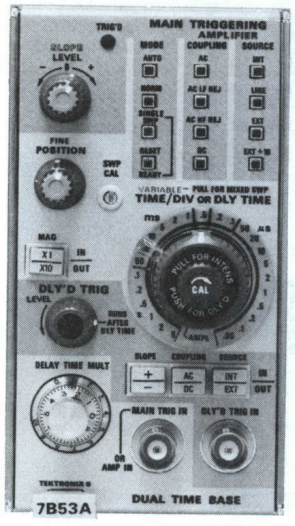
**External Trigger Input** — Maximum Input Voltage: 250 V (dc + peak ac) for 1 MΩ input, 1 W average for 50 Ω input. Input R and C: 1 MΩ within 5% and 20 pF within 10%; for 50 Ω input, 50 Ω within 2%. Level Range: At least ±3.5 V in Ext ÷ 1.

## ORDERING INFORMATION

**7B10** Time Base **$2,495**
**Includes:** Instruction manual (070-2316-00).

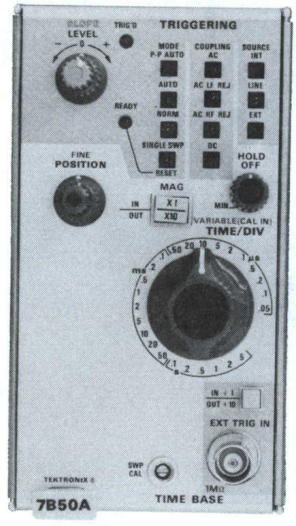
**7B15** Delaying Time Base **$2,830**
**Includes:** Instruction manual (070-2318-00).

7B53A




Dual Time Base

7B50A




Time Base

# 7B53A/7B50A

**5 ns/div to 5 s/div Calibrated Time Base**

**Triggering to 100 MHz (7B53A) and 150 MHz (7B50A)**

**Variable Trigger Holdoff (7B50A)**

**P-P Auto Triggering (7B50A)**

**Single Sweep Operation**

**Calibrated Mixed Sweep (7B53A)**

**TV Sync Separator Triggering (7B53A Option 05)**

The easy-to-use 7B53A and 7B50A Time Bases are recommended for use with 7600 Series mainframes to provide optimum bandwidth/sweep speed compatibility. They may, however, be used in any 7000 Series mainframe to provide sweep rates of 5 ns/div.

The 7B53A provides normal, intensified delaying, delayed, and mixed sweep.

## CHARACTERISTICS (7B53A)

### DELAYING SWEEP

**Sweep Rate** — Calibrated: 50 ns/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

**Sweep Accuracy** — Measured over the center eight divisions.

| Time/Div | Unmagnified | | Magnified | |
|---|---|---|---|---|
| | +15°C to +35°C | 0°C to +50°C | +15°C to +35°C | 0°C to +50°C |
| 5 s/div to 1 s/div | 3% | 4% | Unspecified | Unspecified |
| 50 ms/div to 0.5 μs/div | 2% | 3% | 2.5% | 4% |
| 0.2 μs/div to 0.05 μs/div | 3% | 4% | 3.5% | 5% |

**Delay Time Multiplier Range** — 0 to 10 times the Delay Time/Div setting from 5 s/div to 1 μs/div.

**Differential Delay Time Measurement Accuracy** — 5 s/div to 1 s/div: ±1.4% of measurement +0.3% of full scale. 0.5 s/div to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is ten times the Delay Time/Div setting. Accuracy applies over the center 8 DTM div from +15°C to +35°C.

**Delay Time Jitter** — 0.05% or less of Time/Div setting.

### TRIGGERING

**Triggering Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 10 MHz | 0.3 div | 100 mV |
| | 10 MHz to 100 MHz | 1.5 div | 500 mV |
| Ac LF Rej*1 | 30 kHz to 10 MHz | 0.3 div | —— |
| | 150 kHz to 10 MHz | —— | 100 mV |
| | 10 MHz to 100 MHz | 1.5 div | 500 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 100 mV |
| Dc | Dc to 10 MHz | 0.3 div | 100 mV |
| | 10 MHz to 100 MHz | 1.5 div | 500 mV |

*1 *Will not trigger on sinewaves of three division or less Int or 1.5 V Ext below 120 Hz.*

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

**Internal Trigger Jitter** — 1 ns or less at 75 MHz.

**External Trigger Input** — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2% and 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext, at least +15 V to −15 V in Ext ÷ 10.

### DELAYED SWEEP

**Sweep Rate** — Calibrated: 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate. The variable control is internally switchable between main, delayed sweep, and variable main sweep holdoff.

**Sweep Accuracy** — Measured over the center eight divisions.

| Time/Div | Unmagnified | | Magnified | |
|---|---|---|---|---|
| | +15°C to +35°C | 0°C to +50°C | +15°C to +35°C | 0°C to +50°C |
| 0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div | 4% | 5% | 4.5% | 6% |
| 50 ms/div to 0.5 μs/div | 3% | 4% | 3.5% | 5% |

**Delayed Sweep Gate** — Output Voltage: ≈ +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Risetime: 50 ns or less. Output R is 350 Ω within 10%. Gate is available at the Dly'd Trig In connector when the delayed sweep source switch is set to Int.

**Triggering Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 10 MHz | 0.3 div | 100 mV |
| | 10 MHz to 100 MHz | 1.5 div | 500 mV |
| Dc | Dc to 10 MHz | 0.3 div | 100 mV |
| | 10 MHz to 100 MHz | 1.5 div | 500 mV |

**Internal Trigger Jitter** — 1 ns or less at 75 MHz.

**External Trigger Input** — Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C: 1 MΩ within 2% and 20 pF within 2 pF. Level Range: At least +1.5 V to −1.5 V in Ext.

### MIXED SWEEP

**Sweep Accuracy** — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: First 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

### EXT HORIZONTAL INPUT

**Deflection Factor** — 10 mV/div within 10% when in Ext, Mag X10; 100 mV/div within 10% when in Ext; 1 V/div within 10% when in Ext ÷ 10.

**Bandwidth**

| Coupling | Lower −3 dB | Upper −3 dB |
|---|---|---|
| Ac | 40 Hz | 2 MHz |
| Ac LF Rej | 16 kHz | 2 MHz |
| Ac HF Rej | 40 Hz | 100 kHz |
| Dc | Dc | 2 MHz |

### TV SYNC

**Option 05, TV Sync Separator Triggering** — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed circuit TV systems, domestic or international, with up to 1201-line, 60 Hz field rates. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system. Option 05 deletes ac line trigger and Ext ÷ 10 from trigger source.

## CHARACTERISTICS (7B50A)

**Sweep Rates** — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 Magnifier. Uncalibrated: Variable continuously between steps to at least 2.5 times the calibrated sweep rate.

**Sweep Accuracy** — Measured over center eight division, +15°C to +35°C, with any 7000 Series mainframe. Derate accuracies by an additional 1% each for 0°C to +50°C.

| Time/Div | Unmagnified | Magnified |
|---|---|---|
| 5 s/div to 1 s/div | 4% | Unspecified |
| 0.5 s/div to 0.5 μs/div | 2% | 3% |
| 0.2 μs/div to 0.05 μs/div | 3% | 4% |

### TRIGGERING

**Trigger Holdoff Time**

| | |
|---|---|
| Minimum 5 s/div to 1 μs/div | 2 times Time/Div setting or less |
| 0.5 μs/div to 50 ns/div | 2.0 μs or less |
| Variable | Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster |

**Triggering Sensitivity*1**

| Coupling | Triggering Frequency Range*2 | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 Hz to 50 MHz | 0.3 div | 50 mV |
| | 50 MHz to 150 MHz | 1.5 div | 250 mV |
| Ac LF Rej*3 | 30 kHz to 50 MHz | 0.3 div | 50 mV |
| | 50 MHz to 150 MHz | 1.5 div | 250 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 50 mV |
| Dc*4 | Dc to 50 MHz | 0.3 div | 50 mV |
| | 50 MHz to 150 MHz | 1.5 div | 250 mV |

*1 *Auto and Norm modes.*

*2 *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Int mode.*

*3 *Will not trigger on sinewaves of less than eight division Internal, or 3 V External, at or below 60 Hz.*

*4 *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

**Triggering Sensitivity (P-P Auto Mode)**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac or dc | 200 Hz to 50 MHz | 0.5 div | 125 mV |
| Ac or dc | 50 MHz to 150 MHz | 1.5 div | 375 mV |

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep until reset.

**Option 02, X-Y Display Capability** — A front panel switch selects either normal sweep displays or X-Y displays. In the X-Y mode, the X and Y signals are applied to the inputs of a dual-trace vertical amplifier or two single-trace vertical amplifiers. The X signal is routed via the amplifier/mainframe trigger path to the 7B50A Option 02, and then to the mainframe horizontal amplifier for display.

### ORDERING INFORMATION

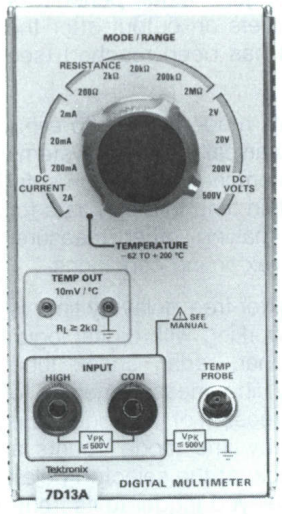
**7B53A** Dual Time Base **$1,685**
**Includes:** Instruction manual (070-1342-01).

**Option 05** — TV Triggering. **+$160**
**Includes:** Instruction manual (070-1471-00).

**7B50A** Time Base **$1,075**
**Includes:** Instruction manual (070-1986-00).

**Option 02** — X-Y Display Capability. **+$105**

**7D13A**




**Digital Multimeter**

# 7D13A

**3 1/2 Digit CRT Readout**

**500 V Maximum Common-Mode Voltage**

**Temperature Mode**

The 7D13A Digital Multimeter is designed for use in all 7000 Series oscilloscope mainframes with CRT readout. The 7D13A functions in any compartment.

The 7D13A measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6601 temperature probe. The temperature probe functions regardless of 7D13A mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 V). Temperature may be measured simultaneously along with any other function.

When the 7D13A is used, the character generator traces out a 3 1/2-digit display on the CRT and a legend for units such as kΩ, mA, °C.

### CHARACTERISTICS

**Dc Voltage Range** — 0 V to 500 V in four ranges. 3 1/2-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 500 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +35°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Maximum safe input is 500 V peak between either contact and ground, 500 V peak between voltage contacts.

**Dc Current Range** — 0 A to 2 A in four ranges. 3 1/2-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +35°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum input is 3 A (fuse protected).

**Resistance Range** — 0 Ω to 2 MΩ in five ranges. 3 1/2-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +35°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

**Temperature Measurement Range** — −62°C to +200°C in one range. 3 1/2-digit presentation to +200°C.

**Temperature Measurement Accuracy*1**

| 7D13A Operating Conditions | Temperature Value Measured | Measurement Accuracy |
|---|---|---|
| +18°C to +28°C (room temperature) | −62°C to +150°C | ±2°C |
| | +150°C to +200°C | 0°C, −6°C |
| 0°C to +18°C +28°C to +50°C | −62°C to +200°C | Add 1.5°C to above tolerance in each direction |

*1 *Probe calibrated to the instrument.*

**Settling Time** — 1 s or less (voltage, current, and resistance modes).

**Polarity** — Automatic indication.

**Maximum Common-Mode Voltage** — 500 V peak between two terminals and ground.

**Normal-Mode Rejection Ratio** — At least 30 dB at 60 Hz.

**Common-Mode Rejection Ratio** — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

**Over Range Indication** — When over range occurs, the readout blinks and the most significant digit displays a three.

**Temperature Out** — 10 mV/°C into a load of at least 2 kΩ.

### ORDERING INFORMATION

**7D13A** Digital Multimeter **$1,280**
**Includes:** Pair of test leads (003-0120-00); P6601 Temperature Probe package (010-6601-01); instruction manual (070-3972-00).

For recommended probes see pages 191 and 426.

**7D11**

**Digital Delay Unit**

# 7D11

**Delay by Time or Events**

**Digital Delay Readout to 7½ Digits**

**100 ns to 1 s Delay Time**

**1 ns Resolution**

**2.2 ns Delay Time Jitter**

**0.5 ppm (±2 ns) Accuracy**

**Delay Interval CRT Display**

The 7D11 Digital Delay plug-in gives stable delayed triggers for measurements requiring low jitter and also provides precision time delays. It provides a variety of outputs and may be used in any compartment of a 7000 Series mainframe equipped with CRT readout.

In the delay-by-events mode, the 7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see Figure 2).

The delay-by-events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

An accurate and jitter-free delay-by-time is very useful when working with digital logic, pcm telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

When the 7D11 is installed in a vertical compartment, the CRT can display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D11 triggers on. From a vertical compartment, the 7D11 can trigger a time base such as 7B80, 7B53A, or another 7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates a display similar to the "A intensified by B" mode of conventional delayed sweep. When used in the A horizontal compartment, the 7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1 MHz timing standard through the Ext 1 MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc, the CRT readout would display the "one-way-trip" time.

## CHARACTERISTICS

### EVENTS DELAY

**Events Delay Range** — One to $10^7$ events.

**Delay Increment** — One event.

**Insertion Delay** — 35 ns ±5 ns.

**Recycle Time** — <500 ns.

**Maximum Event Frequency** — At least 50 MHz.

### TRIGGERING

**External Trigger**

| | |
|---|---|
| Source | Int, Line, Ext, Ext ÷ 10 |
| Coupling | Dc, Ac, Ac LF Rej, Ac HF Rej |
| Max Input Voltage | 250 V Dc + peak Ac |
| Level Range | ±1.75 V in Ext<br>±17.5 V in Ext ÷ 10 |
| Input R and C | 1 MΩ ±5%, 20 pF ±2 pF |

**Triggering Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext |
|---|---|---|---|
| Ac | 30 kHz to 10 MHz | 0.3 div | 150 mV |
| | 10 MHz to 50 MHz | 1.0 div | 750 mV |
| Ac LF Rej*[1] | 30 kHz to 10 MHz | 0.3 div | —— |
| | 150 kHz to 10 MHz | —— | 150 mV |
| | 10 MHz to 50 MHz | 1.0 div | 750 mV |
| Ac HF Rej | 30 Hz to 50 kHz | 0.3 div | 150 mV |
| Dc | Dc to 10 MHz | 0.3 div | 150 mV |
| | 10 MHz to 50 MHz | 1.0 div | 750 mV |

*[1] *Will not trigger on sinewaves of three division or less Int or 1.5 V Ext below 120 Hz.*

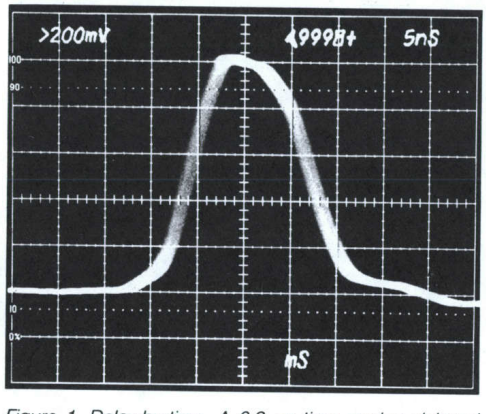



*Figure 1. Delay-by-time. A 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.*

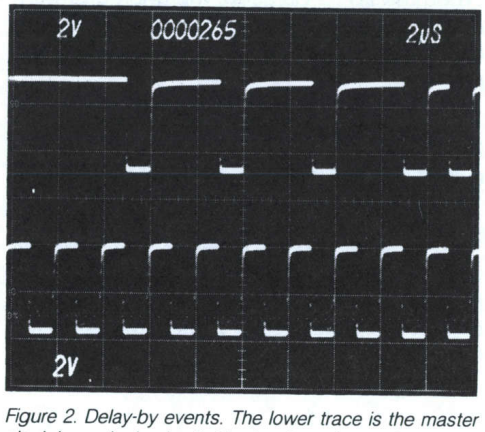



*Figure 2. Delay-by events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.*

### Events Start Trigger

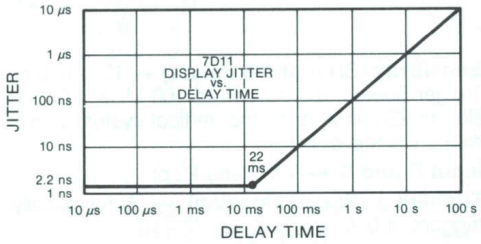
| | |
|---|---|
| Source | External Only |
| Coupling | Dc Only |
| Max Input Voltage | 150 V dc + peak ac |
| Level Range | ±3 V |
| Input R & C | 1 MΩ within 5%, 20 pF ±2 pF |
| Sensitivity | 100 mV min, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz. |

## TIME DELAY

**Digital Delay Range** — Normal Mode: 100 ns to 1 s in 100 ns increments. Echo Mode: 200 ns to 2 s in 200 ns increments.

**Analog Delay** — Continuously variable from 0 ns to at least 100 ns. Accuracy is within 2 ns of indicated delay.

**Jitter With Internal Clock** — 2.2 ns or delay time x $10^{-7}$, whichever is greater.




**Insertion Delay** — Zero within 2 ns.

**Recycle Time** — Less than 575 ns.

**Time Base** — 500 MHz oscillator phase-locked to internal or external clock.

**Clock** — Internal: 5 MHz crystal oscillator. Accuracy is 0.5 ppm. External: 1 MHz within 1%, ac coupled, 50 Ω.

## OUTPUTS

**Delayed Trigger Out** — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime into 50 Ω Load: 2 ns or less. Falltime into 50 Ω Load: 5 ns or less. Pulse Width: 200 ns to 250 ns.

**Delay Interval Out** — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime Into Falltime: 5 ns or less. Accuracy: Equal to delay interval less 20 ns to 30 ns.

## READOUT

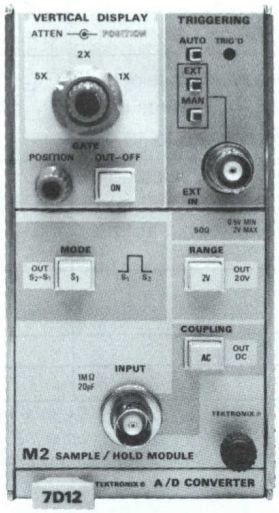
**Display** — 7½ digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the Fine Delay (ns) setting.

## ORDERING INFORMATION

**7D11** Digital Delay Unit **$3,400**

**Includes:** Instruction manual (070-1329-00).

**7D12/M2**




**A/D Converter and Sample/Hold Module**

# 7D12/M2

**Oscilloscope-Controlled Sampling DVM**

**≤10 ns Aperture Uncertainty**

**Input Signal and Sample Points Displayed on CRT**

**1 mV Resolution**

**25 MHz Bandwidth**

**0 V to 2 V and 0 V to 20 V Input Range, 200 V with P6055 Probe**

**Automatic, Manual, or External Triggering**

**Automatic Polarity and Overrange Indicators**

**3½ Digit CRT Readout**

The 7D12 is designed for use with all 7000 Series oscilloscope mainframes with CRT readout.

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together providing a visual indication of where the sample(s) is taken. In the $S_1$ mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken, and the voltage amplitude, from the 0 V level, is digitally displayed on the CRT readout. In the $S_2-S_1$ mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the CRT readout.

## CHARACTERISTICS

**Sample-Gate Display Amplitude** — Two division, risetime and falltime 5 ns or less.

**Analog-Signal Display** — Bandwidth is dc to 25 MHz (dc coupling), 3.4 Hz to 25 MHz (ac coupling). Vertical Sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

**Input R and C** — 1 MΩ and 20 pF.

**Maximum Input Voltage** — 100 V peak.

**Measurement Readout** — 0 V to 20 V in two ranges. 3½ digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 Probe.

**Overrange Indication** — When overrange occurs, a >symbol appears to the left of the reading.

**Aperture Uncertainty** — 10 ns or less.

**Pulse-Width Sample Time ($S_2$-$S_1$ Mode)** — 30 ns to 5 ms with repetitive signal. 150 µs to 5 ms with single-shot signal.

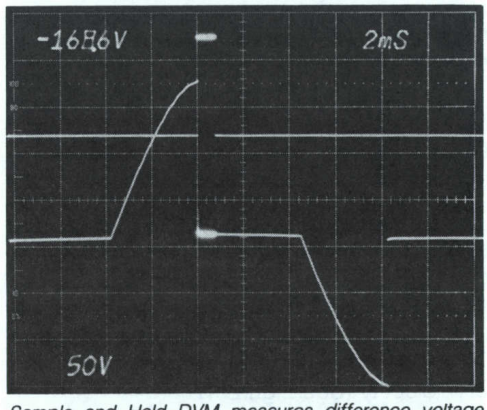
**Measurement Rate** — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

**Accuracy Without Probe*1**

| Temperature Range | $S_1$ Mode | $S_2$ - $S_1$ Mode |
|---|---|---|
| +20°C to +30°C | ±0.15% of p-p input voltage, ±0.1% of reading, ±2 counts, ± the percentage of ac decay*2 | ±0.25% of p-p input voltage, ±0.15% of reading, +2 counts, ± the percentage of ac decay*2 |
| +15°C to +40°C | 0.25% of p-p input voltage, ±0.2% of reading, ±3 counts, the percentage od ac decay*2 | ±0.35% of p-p input voltage, ±0.25% of reading. ±3 counts, ± the percentage of ac decay*2 |

*1 *40 ns after Input Signal Step Function.*

*2 *Applicable when M2 is ac coupled.*




*Sample and Hold DVM measures difference voltage (−168.6 V) between two points on complex waveform. Gate waveform indicates two points; leading and trailing edges where voltage difference is made.*

## ORDERING INFORMATION

**7D12** A/D Converter (Module Not Included) **$1,775**

**Includes:** Instruction manual (070-1469-00).

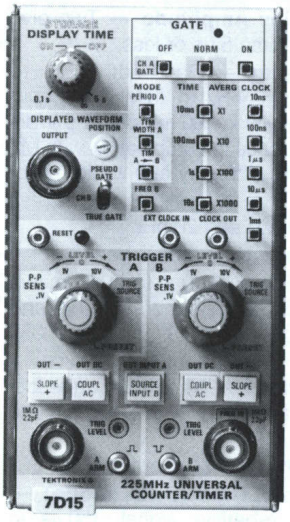
**M2** Sample/Hold Module **$1,550**

**Includes:** In addition to above, 3.5 ft P6055 probe package (010-6055-01).

**Option 02** — Without P6055. **−$100**

**For recommended probes see pages 191 and 426.**

**7D15**




**225 MHz Counter/Timer**

| Modes | Range | Accuracy |
|---|---|---|
| Frequency Mode | Dc to 225 MHz<br>Resolution 0.1 Hz max | $\epsilon_{Freq(Hz)} = \pm TB \bullet f_{in} \pm \frac{1}{T}$ |
| Period and Multi-Period Mode | 10 ns to $10^5$ seconds with selected averaging of 1 to 1000 events in decade steps. Resolution to 10 ps. | $\epsilon_{Period(s)} = \pm TB \bullet P_{in} \pm \frac{10^{-9}}{N} \pm \frac{2E_{npk}}{\frac{dv}{dt}} \bullet N \pm \frac{P_{ck}}{N}$ |
| Time Interval (TI) and TI Average Mode | 6 ns to 10 seconds with selected averaging of 1 to 1000 in decade steps. Resolution is 0.1 ns. | $\epsilon_{TI(s)} = \pm TB \bullet P_{in} \pm \frac{P_{ck}}{\sqrt{N}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$ |
| Frequency Ratio, CH B/Ext Clock | $10^{-7}$ to $10^4$ | |
| Manual Stop Watch | 0 to $10^5$ seconds | |
| Totalize, CH B | 0 to $10^8$ counts | |

*Note: Formulas given where $\epsilon$ is the error; TB (expressed as a decimal) is the time base accuracy; $P_{in}$ is the period of time interval of unknown signal; N is the number of events averaged; $P_{ck}$ is the measurement clock period; T is the gate time; $f_{in}$ is the frequency of the unknown signal; $E_{npk}$ equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second).*

# 7D15

**Oscilloscope-Controlled Time and Frequency Measurements**

**10 ns Single-Shot Time Interval Measurement Resolution**

**Time Interval Averaging**

**CRT Display of Counting Interval**

**10 ps Period-Averaging Resolution**

**Frequency Measurements Directly to 225 MHz**

**Signal Conditioning via Mainframe Trigger Source**

For Measurement Applications Guide order 42W-5017-1.

The 7D15 Universal Counter/Timer is designed for use in all 7000 Series oscilloscope mainframes with CRT readout.

The 7D15 can be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, measurements can be made between any two points on the CRT display (See Figure 1).

The 7D15 offers all the measurement capabilities of a Universal Counter/Timer, such as time interval, period, period and time interval averaging, frequency, frequency ratio, totalize, and manual stop watch.

The 7D15 may be used in vertical or horizontal compartments of 7000 Series mainframes. It provides a full eight-digit CRT display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

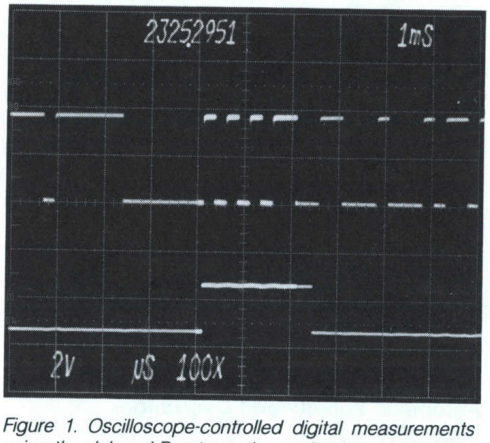



*Figure 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time interval measurement from third to seventh pulse on CRT display. Counter CH A is "armed" with leading edge of B gate while CH B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 µs.*

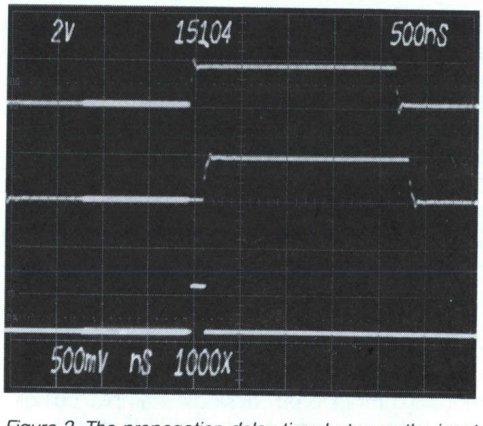



*Figure 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.*

## CHARACTERISTICS

### INPUT SIGNAL CH A & B

**Frequency Range (CH B Only) —** Dc Coupled: Dc to 225 MHz. Ac Coupled: 5 Hz to 225 MHz.

**Sensitivity (CH A and B Inputs) —** 100 mV p-p. Trigger Source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

**Input R and C —** 1 MΩ and 22 pF.

**Triggering (Preset Position) —** Automatically triggers at 0 V.

**Level Control Range (CH A and B Inputs) —** 100 mV Range: ±500 mV. 1 V Range: ±5 V. 10 V Range: ±50 V.

**Arming Inputs —** Input R and C: 10 kΩ and 20 pF. Sensitivity Arm A: Logical 1 ⩾ +0.5 V, logical 0 ⩽ +0.2 V. Sensitivity Arm B: Logical 1 ⩽ +0.2 V, logical 0 ⩾ +0.5 V.

**External Clock-In —** 20 Hz to 5 MHz.

**Reset Front Panel —** Readies the instrument. All counters are affected, including averaging circuits.

### INTERNAL TIME BASE

**Crystal Oscillator —** Accuracy: Within 0.5 ppm (0°C to +50°C ambient). Long-Term Drift: 1 part or less in $10^7$ per month. Oscillator: Temperature compensated; no warm up is required.

### OUTPUT SIGNALS

**Clock Out —** Logical 1 ⩾ +0.5 V into 50 Ω. Logical 0 ⩽0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

**A and B Trigger Level —** $Z_{out}$ ≈1 kΩ, $V_{out}$ = ±0.5 V into 1 MΩ.

**Displayed Waveform (Internally Connected) —** Front-panel switch screwdriver controlled selects true gate, pseudo gate, or CH B signal out.

**External Display —** Same as internal except position control has no effect.

**Display Mode Switch —** 0.1 s to 5 s; also a preset position for infinite display time. Allows selection of readout "follow or store."

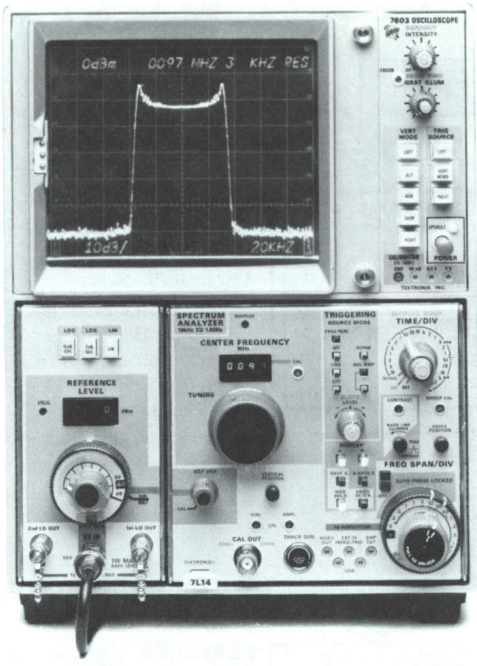
**Readout —** Eight-digit display; the four most significant have zero suppression. Overflow indicated by a greater than symbol.

## ORDERING INFORMATION

**7D15** Universal Counter/Timer **$3,495**

**Includes:** Two 44 inch Sealectro to BNC connector cables (012-0403-00); instruction manual (070-1433-00).

For recommended probes see pages 191 and 426.




## 7L14

**Excellent Stability, Resolution Bandwidth Range**

**Digital Storage and Averaging**

**Swept Measurements with the Tek TR502**

**1 kHz to 2.5 GHz Coverage (Option 39)**

**Input Limiter for Extra Input Protection**

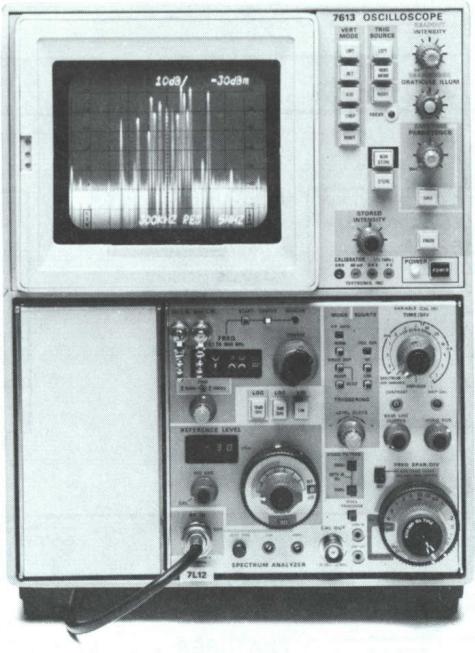
**Semiautomatic Measurements with the Tek 7854**

The Tektronix 7L14 is a VHF/UHF analyzer with digital storage. It provides high performance in the 10 kHz to 1.8 GHz range. Measurements for RFI/EMC, FM, TV, avionics, navigation, two-way and other communications sytems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability—incidental FM is ≤13 Hz peak-to-peak. Phase noise sidebands are no greater than −70 dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more...easily and economically.

For a complete description of the 7L14 see page 166.




## 7L12

**Proven, Economical VHF/UHF Coverage**

**Automatic Phaselock, 300 Hz Resolution Bandwidth**

**Swept Measurements with the TR 502**

**Coverage to 2.5 GHz (Option 39)**

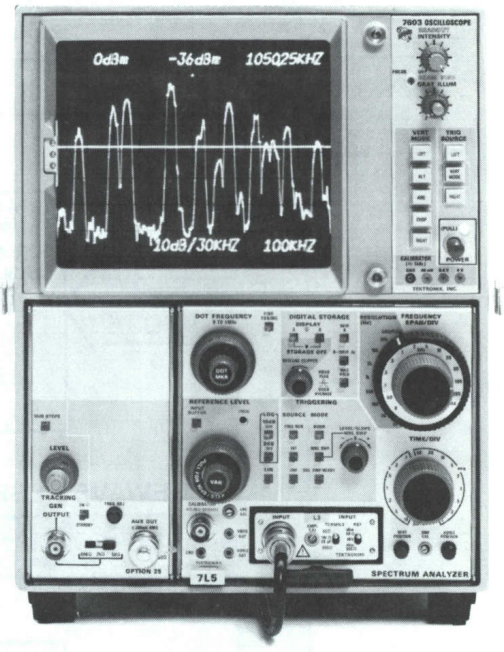
**Semiautomatic Measurements with the Tek 7854**

The 7L12 is a popular instrument in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with −115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is ≤200 Hz peak-to-peak.

The 7L12 meets the measurement requirements of many AM, FM, two-way radio and other communications systems.

The 7L12 has a 70 dB spurious-free display dynamic range; low level noise measurements are made accurately, easily.

For a complete description of the 7L12 see page 168.




## 7L5

**Synthesizer Tuning**

**Digital Storage and Averaging**

**Three-Knob Operation**

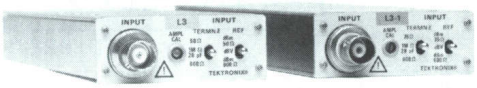
**Preset Reference Level and Dot Frequency for Extra Input Protection**

**Swept Measurements (Option 25)**

**Selectable Input Impedance; Calibration in dBm, dBV or Volts Per Division**

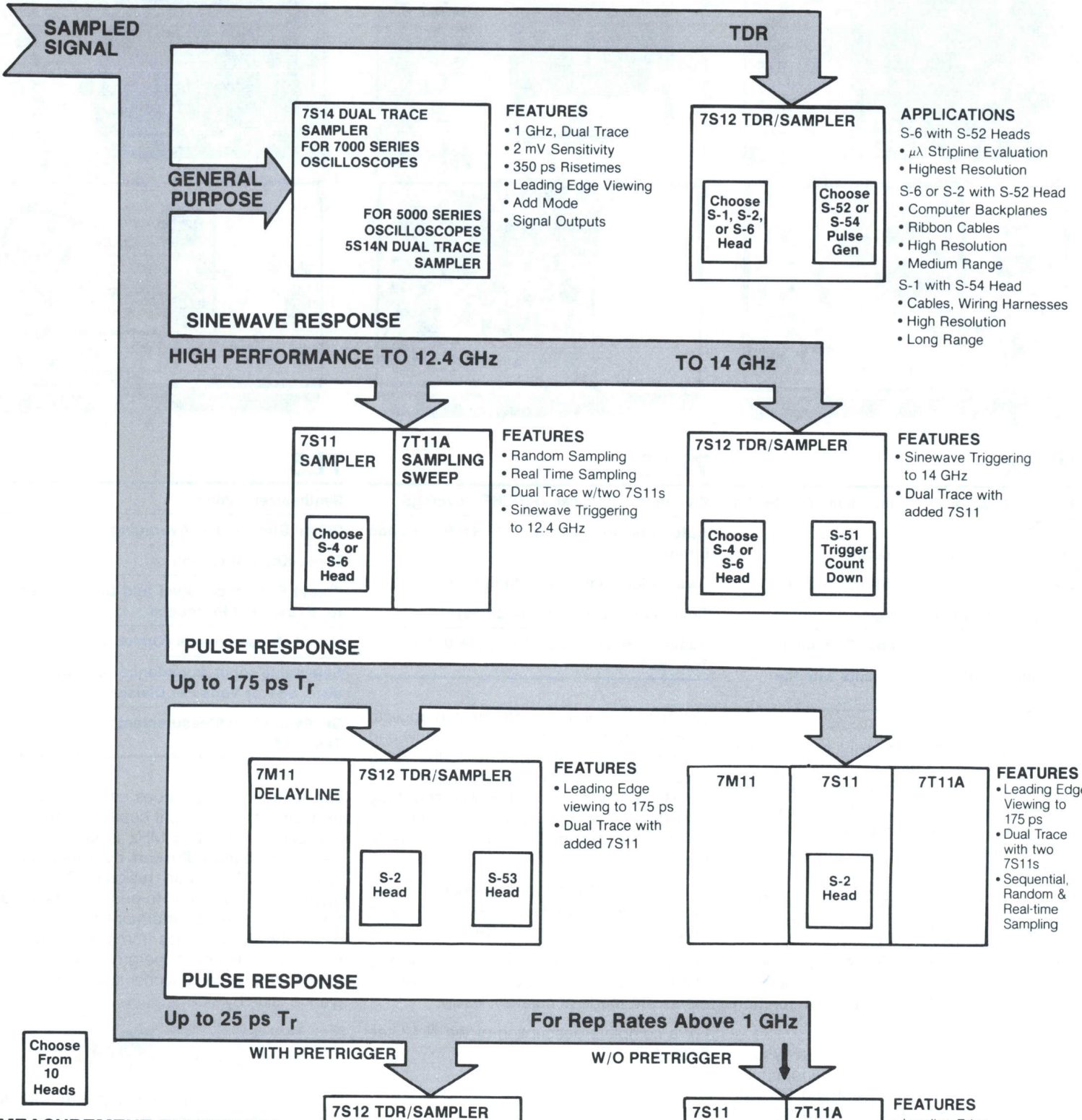
**Semiautomatic Measurements with the Tek 7854**

The Tektronix 7L5 provides easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.




Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω or 1 MΩ. The L3 Option 01 is switch-selectable to 75 Ω, 600 Ω or 1 MΩ.

For a complete description of the 7L5 see page 170.




## MEASUREMENT FLEXIBILITY

- Dc to 350 MHz ($T_r$ 1 ns) 1 MΩ—S-5
- Dc to 1 GHz ($T_r$ 350 ps) 50 Ω—S-1
- Dc to 1 GHz ($T_r$ 350 ps) 100 kΩ—S-3A
- Dc to 4.6 GHz ($T_r$ 75 ps) 50 Ω—S-2
- Dc to 11.5 GHz ($T_r$ 30 ps) 50 Ω—S-6
- Dc to 14 GHz ($T_r$ 25 ps) 50 Ω—S-4
- 1 GHz to 18 GHz Sinewave Trigger Countdown—S-51
- ≤25 ps $T_r$ Pulse Generator—S-52
- Dc to 1 GHz Trigger Recognizer—S-53
- ≤1 ns $T_r$ Pulse Generator—S-54

### Sampling Plug-ins

7000 Series sampling plug-ins can increase the versatility of your mainframe by providing measurement capabilities up to 14 GHz on repetitive signals. The Sampling family consists of five plug-ins, ten specially-designed sampling heads, and various supporting accessories that provide maximum configurability for numerous applications.

Specific uses for samplers include general UHF measurement and TDR (Time Domain Reflectometry).

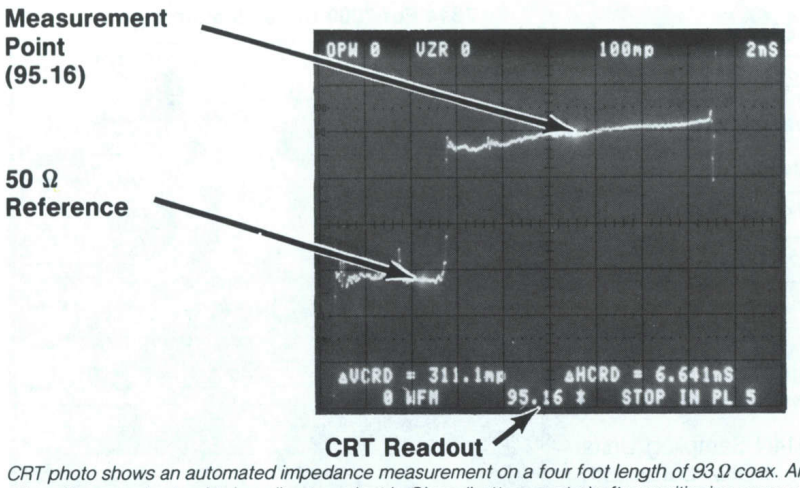
### UHF Measurements

For flexibility in time domain measurement, the 7S11 Sampling Unit/7T11 Sampling Sweep combination provides triggering to 12.4 GHz, and the choice of modular heads for optimum signal acquisition. Two 7S11's and one 7T11 provide dual-trace capability. For plug-in sampler operationally similar to conventional vertical/time base plug-ins, the 1 GHz 7S14 is available. Two identical channels provide 2 mV/div sensitivity, dual trace display, built-in time base, and calibrated delayed sweep. All of these plug-ins provide a cost-effective way to obtain Gigahertz measurement capability for repetitive signals.

### TDR

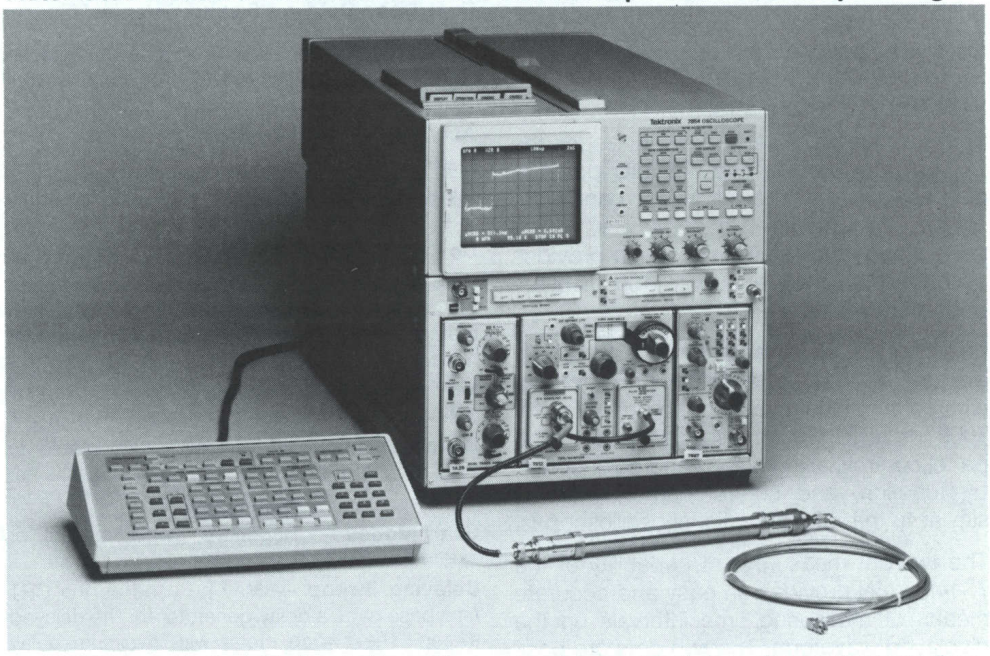
TDR is widely used in microwave stripline evaluation, computer backplane measurements, and printed circuit board testing. With TDR, a pulse is sent down a conductive path and measured as it reflects back from any impedance changes in the device under test. Any impedance variations in the path cause a corresponding signal to be displayed on the scope. The precise location and type of impedance anomaly (open, short, step change) in the conductive path is directly readable on the display. The fast risetimes of samplers make them well suited for these measurements. The high resolution 7S12 TDR Sampler provides maximum versatility in addition to general purpose applications.

Use the Sampling Decision Tree diagram on the preceding page to select the configuration for your measurement requirement.




*CRT photo shows an automated impedance measurement on a four foot length of 93 Ω coax. An easy-to-use program allows the operator to obtain a direct readout in Ohms (bottom center) after positioning cursors on selected points on the display.*

### Automated Measurements with the 7854 Oscilloscope and 7S12 Sampler Plug-in



*The 7854/7S12 combination is ideally suited for making a wide variety of automated sampling measurements. Examples of easy-to-program measurements are: measuring propagation delay through active or passive devices; measuring distance to faults in coax cables; and measuring impedance in EC boards and other controlled-impedance devices. Programs can be entered into the 7854 via the calculator keyboard for simple operator-controlled measurements, or tests can be computer-controlled via a remote terminal on the GPIB for production applications.*

### SAMPLING HEAD CHARACTERISTICS

| | Bandwidth | Risetime | Input Impedance | Noise | Connector |
|---|---|---|---|---|---|
| S-1 | Dc to 1 GHz | ≤350 ps | 50 Ω | ≤1 mV*1 ≤2 mV*2 | GR |
| S-2 | Dc to 4.6 GHz | ≤75 ps | 50 Ω | ≤3 mV*1 ≤6 mV*2 | GR |
| S-3A | Dc to 1 GHz | ≤350 ps | — 100 kΩ | ≤3 mV at probe tip*2 | Probe |
| S-4 | Dc to 14 GHz | ≤25 ps | 50 Ω | ≤2.5mV*1 ≤5 mV*2 | SMA (3 mm) |
| S-5 | Dc to 350 MHz | ≤1 ns | 1 MΩ | ≤500 μV*1 ≤5 mV*2 | BNC |
| S-6 | Dc to 11.5 GHz | ≤30 ps | 50 Ω feed thru | — ≤5 mV*2 | SMA (3 mm) |

*1 Smoothed
*2 Unsmoothed

### ACCESSORY PROBES FOR 50 Ω SAMPLERS

**Passive**

| Type | Attenuation | Length*1 | Loading | | Risetime (in ns) | Bandwidth | Package Number*2 |
|---|---|---|---|---|---|---|---|
| P6056 | 10X | 6.0 | 500 Ω | 1 pF | <0.1 | Dc to 3.5 GHz | 010-6056-03 |
| P6057 | 100X | 6.0 | 5 kΩ | 1 pF | <0.25 | Dc to 1.4 GHz | 010-6057-03 |

**Active — FET*3**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P6201 | 1X | 6.0 | 100 kΩ | 3 pF | <0.4 | Dc to 900 MHz | 010-6201-01 |
| | 10X | 6.0 | 1 MΩ | 1.5 pF | <0.4 | Dc to 900 MHz | (includes |
| | 100X | 6.0 | 1 MΩ | 1.5 pF | <0.4 | Dc to 900 MHz | attenuators) |
| P6202A | 10X | 2 m | 10 MΩ | 2 pF | <0.7 | Dc to 500 MHz | 010-6202-03 plus |
| | 100X | 2 m | 10 MΩ | 2 pF | <0.7 | Dc to 500 MHz | 010-0384-00 to provide 100X |

**Active — Variable Bias/Offset*3**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| P6230 | 10X | 1.6 | 450 Ω | 1.6 pF | ≤0.23 ps | Dc to 1.5 GHz | 010-6230-01 |

*1 Length in feet except where specified.
*2 Refer to probe section for additional information.
*3 Requires power source: Most four compartment mainframes provide probe power. See page 425 for Probe Power Supplies.

# 7S14/5S14N

**Calibrated Delayed Sweep**

**Two-Dot Time Measurement**

**Dc to 1 GHz Bandwidth**

**Dual Trace, 2 mV Sensitivity**

**CRT Readout (7S14 Only)**

**Simplified Triggering**

**Operational Ease of a Conventional Oscilloscope**

The 7S14 and 5S14N Sampling Units provide dual-trace 1 GHz bandwidth in the 7000 and 5000 Series oscilloscope mainframes, respectively. Operation and specifications of the two units are identical except that the 5S14N does not provide CRT readout. Each of the units occupies two plug-in compartments of a mainframe.

The two identical vertical channels of the 7S14/5S14N provide two millivolts per division sensitivity at the full 1 GHz bandwidth of the instrument. The 7S14/5S14N also uses a two-ramp time base which provides calibrated delayed sweep to 100 picoseconds per division.

Learning to operate the 7S14/5S14N requires a minimum of effort for those familiar with conventional oscilloscope operation for 7000 or 5000 Series oscilloscopes. Front-panel controls are grouped and color coded by function, and control nomenclature is similar to that of conventional oscilloscopes.

The two-dot measurement capability of the 7S14/5S14N provides an easy and accurate means of measuring time intervals on the displayed waveform. The two dots are positioned by the Delay controls; the time interval between them is determined by multiplying the Delay Time Multiplier setting by the selected time per division. This eliminates the need to interpolate between graticule markings on the CRT.

## CHARACTERISTICS

The following specifications are identical for both units unless otherwise noted.

### VERTICAL CHANNEL

**Modes** — CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 Invert); CH 1 Vertical (Y), CH 2 Horizontal (X).

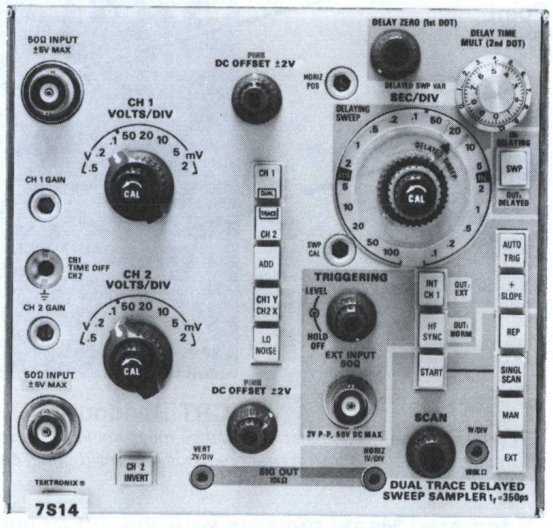
**Input Impedance** — Nominally 50 Ω.

**Bandwidth** — Equivalent to dc to 1 GHz.

**Risetime** — 350 ps or less.

**Step Aberrations** — +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, both tested with a 284 Pulse Generator.

**7S14 For 7000 Series Mainframes**




**Dual Trace Delayed Sweep Sampler*1**

**Deflection Factor** — 2 mV/div to 0.5 V/div in eight steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

**Accuracy** — Within ±3%.

**Maximum Input Voltage** — ±5 V.

**Input Signal Range** — 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.

**Dc Offset Range** — At least +2 V to −2 V.

**Displayed Noise** — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

**Vertical Signal Output** — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

**Channel Delay Difference** — Adjustable to zero, or for any time difference up to at least 1 ns.

### TIME BASE

**Scan Modes** — Repetitive, single, manual, or external.

**Delaying Sweep** — May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the Time/Div.

**Delayed Sweep** — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

**Horizontal Signal Output** — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

### DELAYING SWEEP

**Range** — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

**Accuracy** — Within ±3%, excluding first 0.5 division of displayed sweep.

**Delayed Zero (1st Dot)** — Adjustable to correspond to any instant within the time interval represented by the first nine division of the delaying sweep selected.

**Delay Time (2nd Dot)** — Adjustable to any position of the time interval represented by ten division of the delaying sweep selected.

**Delay Accuracy** — Within ±1% of ten division when measurement is made within the last 9.5 division.

### DELAYED SWEEP

**Range** — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

**Accuracy** — Within ±3% excluding first 0.5 division of displayed sweep.

**Start Delay** — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by ten divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

**Delay Jitter** — <0.05% of the time represented by one division of the delaying sweep selected.

### TRIGGERING AND SYNC

**Signal Sources** — Internal from CH 1 vertical input or external through front-panel connector.

**External Triggering** — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

**Internal Triggering** — Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

**Triggered Mode** — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

**Autotrigger Mode** — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the p-p voltage of the signal.

**Holdoff** — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

**HF SYNC Mode** — For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

## ORDERING INFORMATION

**7S14** Dual-Trace Delayed Sweep Sampler for 7000 Series Oscilloscopes **$6,095**

**Includes:** Two X10 attenuators (011-0059-02); two 42 in 50 Ω coaxial cables (012-0057-01); instruction manual (070-1410-00).

**5S14N** Dual-Trace Delayed Sweep Sampler for 5000 Series Oscilloscopes **$6,355**

**Includes:** Same as 7S14 with instruction manual (070-1409-00).

*1 *5S14N for 5000 Series mainframes shown on page 252.*

# 7S12

**45 ps TDR or a General Purpose Sampler**

**6 Plug-In Sampling Heads Available**

**2 Plug-In Pulse Sources Available**

**1 Trigger Recognizer Head Available**

**1 Trigger Countdown Head Available**

The 7S12 is a combined vertical-horizontal, double-width plug-in for high resolution TDR or general purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination) and distance range to 250 feet in any cable. Its vertical scale is calibrated in reflection coefficient ($\rho$) from 2 m$\rho$/div to 500 m$\rho$/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line TDR using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 feet (air line) and discontinuities to twice this distance may be viewed. System risetime with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

## CHARACTERISTICS

### SYSTEM PERFORMANCE WITH S-6 AND S-52

**System Risetime** — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

**Time and Distance Ranges** — Direct-reading tape dial gives calibrated one-way distance to at least 375 ft (air line). Time range is at least 0.75 $\mu$s round trip. Both ranges are limited by the duration of the pulse from the S-52.

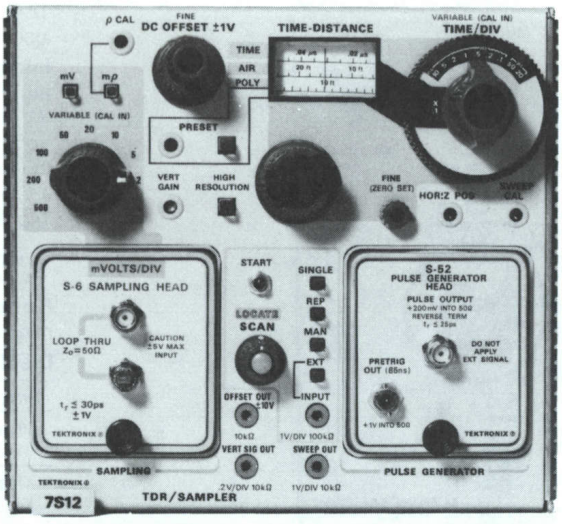
**Pulse Amplitude** — At least +200 mV into 50 Ω.

**Input Characteristics** — Nominal 50 Ω, feedthrough signal channel (termination supplied). SMA (3 mm) connectors.

**Jitter** — <10 ps (without signal averaging).

**Aberrations** — +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

7S12




TDR/Sampler

### TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

**System Risetime** — 1.5 ns or less for the displayed reflection from a short-circuited test line.

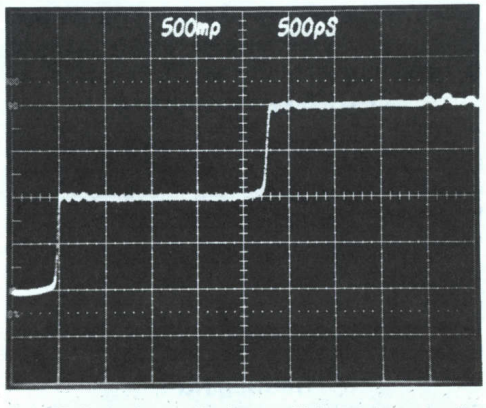
**Time and Distance Ranges** — Direct-reading tape dial gives calibrated one-way distances to 4900 ft (air line), 3240 ft solid polyethylene. Time range is 20 $\mu$s round trip.

**Pulse Amplitude** — At least +400 mV into 50 Ω.

**Input Characteristics** — Nominal 50 Ω test line connection (cable and T supplied). BNC connectors.

**Jitter** — <20 ps (without signal averaging).

**Aberrations** — +4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.




*The 7S12 displays reflection coefficient ($\rho$) versus distance on a device-under-test. Here the 7S12 measures a reflection caused by a crack (open) in a PCB under test. Distance can be read directly from the 7S12 front panel, or calculated from the time base settings.*

### OTHER 7S12 CHARACTERISTICS

**Vertical Scale** — Calibrated in m$\rho$ (reflection coefficient $10^{-3}$) and mV from 2 to 500 units/division in eight steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

**Resolution** — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

**Dc Offset Range** — +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

**Time/Distance** — Tape Dial is Calibrated in Time and Distance: Full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 $\mu$s, 1 $\mu$s, 0.1 $\mu$s (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

**Time/Div** — 20 ps/div to 1 $\mu$s/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

**Locate Button** — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

**Display Modes** — Repetitive or single sweep, manual or external scan.

**Signal Outputs** — Pin jacks provide both vertical signal and sweep outputs.

## ORDERING INFORMATION

**7S12** TDR/Sampler without Sampling Heads (Tape Dial in Feet) **$3,985**

**Includes:** 750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR graticule overlay (331-0296-00); TDR slide rule (003-0700-00); TDR graticule overlay (331-0297-00); instruction manual (070-1244-00).

**Option 03** — Tape Dial Change (Meters). **+$25**

**RECOMMENDED MAINFRAME**

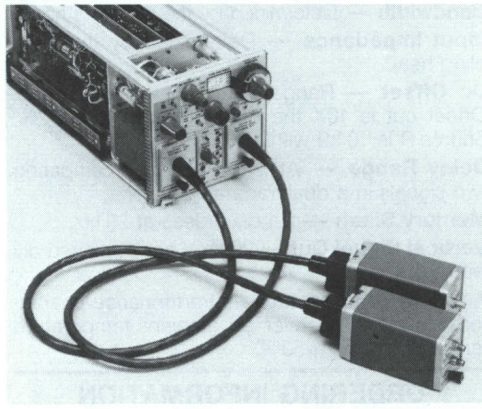
See Page 201

**7603** Oscilloscope Mainframe **$3,250**

## OPTIONAL ACCESSORIES

**3 ft Sampling-Head Extender —**
Order 012-0124-00 **$415**

**6 ft Sampling-Head Extender —**
Order 012-0125-00 **$490**



*Extenders allow the user to locate the sampling head directly in a test fixture, avoiding potential signal degradation by cables.*

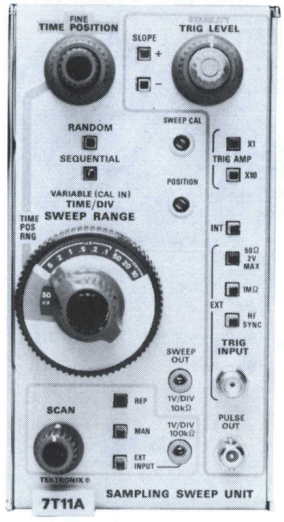
**For sampling heads see pages 235 to 237.**

NOTE: See 1502 and 1503 Portable TDR Cable testers on page 153.

**7S11**

**Sampling Unit**

**7T11A**




**Sampling Sweep Unit**

# 7S11

**2 mV/div to 200 mV/div Calibrated Deflection Factors**

**Plug-In Sampling Heads**

The 7S11 single-channel sampling unit employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used for a variety of applications. Single-channel sampling uses one 7S11 with a 7T11A Time Base. Two 7S11s and one 7T11A provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

## CHARACTERISTICS

**Deflection Factor** — 2 mV/div to 200 mV/div in seven steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous (extends deflection factor from 1 mV/div or less to at least 400 mV/div). Deflection factor is determined by the plug-in sampling head.

**Bandwidth** — Determined by the sampling head.

**Input Impedance** — Determined by the sampling head.

**Dc Offset** — Range, +1 V to −1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.

**Delay Range** — At least 10 ns for comparing two signals in a dual-trace application.

**Memory Slash** — 0.1 div or less at 20 Hz.

**Vertical Signal Out** — 200 mV per displayed div within 3%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

## ORDERING INFORMATION

**7S11** Sampling Unit without Sampling Head **$2,090**

**Includes:** Instruction manual (070-0987-00).

# 7T11A

**10 ps/div to 5 ms/div Calibrated Time Base**

**Random or Sequential Sampling**

**Equivalent or Real Time Sampling**

**No Pretrigger Required**

The 7T11A Sampling Time Base provides equivalent-time and real-time horizontal deflection for single-trace or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from approximately 10 Hz (sequential mode) to above 12.4 GHz. The 7T11A works with all 7000 Series instruments and is a companion unit to the 7S11.

## CHARACTERISTICS

**Time/Division Range** — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated variable is continuous between steps to at least 4 ps/div.

**Time Position Range** — Equivalent time is 50 ns to 50 μs in four steps; real time is 0.05 ms to 50 ms in three steps.

**Time/Division Accuracy** — Within 3% for all time/division settings over center 8 cm.

### TRIGGERING

**External 50 Ω Input** — Frequency range is dc to 1 GHz in 1X Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 50 Ω within 10%. Maximum input voltage is 2 V (dc + peak ac).

**External 1 MΩ Input** — Frequency range is dc to 100 MHz in X1 Trig Amp mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz in X1 Trig Amp, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 Trig Amp. Input R is 1 MΩ within 5%. Maximum input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a minimum 5 V p-p).

**External HF Sync** — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Maximum input voltage is 2 V p-p.

**Internal Trigger Source (Sinewave Triggering)*1** — Frequency range is 5 kHz to 500 MHz in X1 Trig Amp: 5 kHz to 50 MHz in X10 Trig Amp. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 Trig Amp; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 Trig Amp.

*1 *Trigger circuits will operate to dc with pulse triggering, except for HF Sync.*

**Random Mode Trigger Rate** — 100 Hz minimum.

**Display Jitter*1**

| Time Pos Range | Sequential Mode | Random Mode |
|---|---|---|
| 50 μs to 500 ns | 0.4 div or less | 1 div or less |
| 50 ns | 10 ps | 30 ps |

*1 *Measured under optimum trigger conditions with Time/Division switch clockwise.*

**Pulse Out** — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns risetime or less.

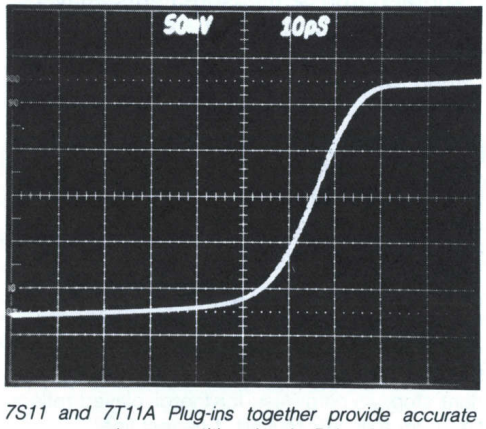
**Trigger Kickout** — 2 mV or less into 50 Ω (except HF SYNC).

**Display Scan Rate** — Continuously selectable from at least 40 sweeps/s to <2 sweeps/s.

**External Scan** — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ with 10%. Maximum input voltage is 100 V (dc + peak ac).

**Sweep Out** — 1 V/div within 2%. Source R is 10 kΩ within 1%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.



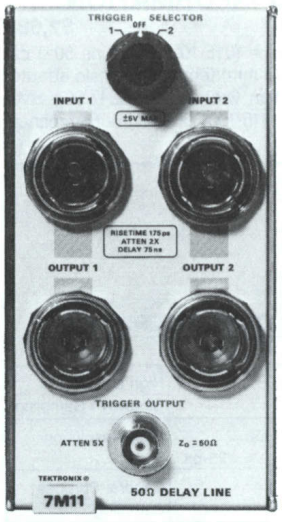

*7S11 and 7T11A Plug-ins together provide accurate measurements on repetitive signals. Pulse risetime of 21 ps shown.*

## ORDERING INFORMATION

**7T11A** Sampling Sweep Unit **$5,240**

**Includes:** 42 inch BNC 50 Ω cable (012-0057-01); 3 mm SMA male to BNC adaptor (015-1018-00); 3 mm SMA male to GR874 adaptor (015-1007-00); 10X 50 Ω attenuator (011-0059-02); instruction manual (070-0986-00).

**7M11**




**Delay Line**

## 7M11

**75 ns Time Delay**

**Selectable Trigger out**

**175 ps Risetime**

The 7M11 is a passive dual delay line for use with the 7000 Series sampling system. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per-division settings.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50 Ω, 75 ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175 ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

### CHARACTERISTICS

#### DELAY LINE

**Time Delay** — 75 ns within 1 ns.

**Delay Difference** — 30 ps or less between channels.

**Risetime** — 175 ps or less.

**Attenuation** — 2X within 2% into 50 Ω.

**Input Impedance** — 50 Ω within 2%.

**Maximum Input** — ±5 V (dc + peak ac).

#### TRIGGER OUTPUT

**Risetime** — 600 ps or less.

**Attenuation** — 5X within 10% into 50 Ω (referred to input).

**Output Impedance** — 50 Ω within 10%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

### ORDERING INFORMATION

**7M11** Delay Line **$1,585**

**Includes:** Two 2 ns GR cables (017-0505-00); ten inch BNC cables (012-0208-00); instruction manual (070-0987-00).

## S-1

**Dc to 1 GHz Bandwidth**

**Clean Transient Response**

**Internal Trigger Pickoff**

The S-1 Sampling Head is a low noise, 350 ps risetime unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

**Risetime** — 350 ps or less.

**Bandwidth** — Equivalent to dc to 1 GHz at 3 dB down.

**Transient Response** — Aberrations as observed with the 284 Pulse Generator are +0.5%, −3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; −0.5% or less, total of 1% or less p-p after 5 ns.

**Displayed Noise** — Smoothed: 1 mV. Unsmoothed: 2 mV or less.

**Signal Range** — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <500 mV p-p.

**Input Characteristics** — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

**Weights** — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

### ORDERING INFORMATION

**S-1** Sampling Head **$1,360**

**Includes:** 5 ns, 50 Ω RG58 A/U cable (017-0512-00); 10X, 50 Ω GR attenuator (017-0078-00); instruction manual (070-0763-00).

## S-2

**Dc to 4.6 GHz Bandwidth**

**Displayed Noise <6 mV (Unsmoothed)**

**Internal Trigger Pickoff**

The S-2 Sampling Head is a 75 ps risetime unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

**Risetime** — 75 ps or less.

**Bandwidth** — Equivalent to dc to 4.6 GHz at 3 dB down.

**Transient Response** — Aberrations as observed with the 284 Pulse Generator are +5%, −5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, −2% or less total of 4% or less p-p after 2.5 ns.

**Displayed Noise** — Smoothed: 3 mV. Unsmoothed: 6 mV or less.

**Signal Range** — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <200 mV p-p.

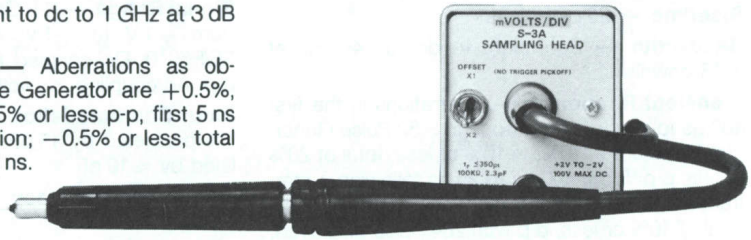
**Input Characteristics** — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

**Weights** — Net: 0.5 kg (1.0 lb). Shipping: 1.4 kg (3.0 lb).

### ORDERING INFORMATION

**S-2** Sampling Head **$1,595**

**Includes:** 50 Ω GR attenuator (017-0078-00); 5 ns, 50 Ω RG213/U Cable (017-0502-00); 10X, instruction manual (070-0764-00).




## S-3A

**Displayed Noise <3 mV (Unsmoothed)**

**Dc to 1 GHz Bandwidth**

**Compact, 4.5 ft, 100 kΩ, 2.3 pF Probe**

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

**Risetime** — 350 ps or less.

**Bandwidth (Probe Only)** — Equivalent to dc to 1 GHz at 3 dB down.

**Transient Response (Probe Only)** — Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

**Displayed Noise (Probe Only)** — 3 mV or less referred to probe tip (includes 90% of dots).

**Signal Range** — Variable dc offset allows signals between +1 V, 1X range, or +2 V and −2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.

**Weight** — Net: 1.4 kg (3.0 lb). Shipping: 2.3 kg (5.0 lb).

### ORDERING INFORMATION

**S-3A** Sampling Head **$2,070**

**Includes:** 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); two test-point jacks (131-0258-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip ground adaptor (013-0085-00); 5½ inch ground lead (175-1017-00); 12½ inch ground lead (175-1018-00); 3 inch cable assembly (195-6176-00); end cap (200-0834-00); three ground clips (344-0046-01); two end caps (200-0835-00); probe holder (352-0090-00); carrying case (016-0121-01); 6 inch elec lead (175-0849-00); 3 inch elec lead (175-0849-00); retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01); instruction manual (070-1148-00).

## S-4

**Displayed Noise <5 mV (Unsmoothed)**

**25 ps Risetime**

**Internal Trigger Pickoff**

The S-4 Sampling Head is a 25 ps risetime unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

**Risetime** — 25 ps or less.

**Bandwidth** — Equivalent to dc to 14 GHz at 3 dB down.

**Transient Response** — Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, −0%, +10% or less, total of 10% or less, p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.

**Displayed Noise** — Smoothed: 2.5 mV. Unsmoothed: 5 mV or less.

**Signal Range** — Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

**Input Characteristics** — Nominally 50 Ω. Safe overload is ±5 V. SMA (3 mm) input connector.

**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

### ORDERING INFORMATION

**S-4** Sampling Head **$3,120**

**Includes:** 10X 50 Ω SMA attenuator (015-1003-00); 2 ns cable with SMA connectors (015-1005-00); GR874 to SMA male adaptor (015-1007-00); SMA male-to-male adaptor (015-1011-00); 5/16 inch wrench (003-0247-00); instruction manual (070-0896-01).

## S-5

**Dc to 350 MHz Bandwidth**

**1 MΩ, 15 pF Input Impedance**

**Passive Probe**

**Internal Trigger Pickoff**

The S-5 Sampling Head is a low-noise, 1 ns risetime sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns risetime at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

**Risetime** — S-5 Only: 1 ns or less. With 3.5 ft P6010: 1 ns or less.

**Bandwidth** — Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.

**Transient Response** — S-5 Only (Driven with a 50 Ω Source Terminated in 50 Ω): Aberrations +2.5%, −5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, −1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft Probe, Properly Compensated): Aberrations +5%, −5% or less total of 10% or less p-p within 25 ns after step; +1%, −1% or less total of 2% or less p-p thereafter.

**Displayed Noise** — S-5 Only: 500 μV or less (includes 90% of dots). S5/P6010: 5 mV or less (includes 90% of dots).

**Signal Range** — S-5 Only: Dc coupled is 1 V p-p from +1 V to −1 V. Ac coupled is 1 V p-p. S5/P6010: Dc coupled (dc + peak ac) is 10 V p-p. Ac coupling, dc voltage is 100 V.

**Input Characteristics** — S-5 Only: 1 MΩ within 1% paralleled by 15 pF. S-5/P6010: 10 MΩ paralleled by ≈10 pF.

**Attenuator Accuracy** — Probe attenuation is 10X within 3%.

**Weight** — Net: 0.3 kg (0.6 lb). Shipping: 0.9 kg (2.0 lb).

### ORDERING INFORMATION

**S-5** Sampling Head **$1,555**

**Includes:** 50 Ω termination (011-0049-01); P6010 probe package (010-0188-00); instruction manual (070-0942-00).

## S-6

**30 ps Risetime**

**Displayed Noise <5 mV (Unsmoothed)**

**Loop-Through Input**

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

**Risetime** — 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

**Bandwidth** — Equivalent to dc to 11.5 GHz at 3 dB down.

**Transient Response** — Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

**Displayed Noise** — 5 mV or less, measured tangentially.

**Signal Range** — +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

**Input Characteristics** — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Safe overload is ±5 V.

**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 0.9 kg (2.0 lb).

### ORDERING INFORMATION

**S-6** Sampling Head **$2,685**

**Includes:** 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) female-to-female adaptor (015-1012-00); combination wrench (003-0247-00); SMA male-to-GR874 adaptor (015-1007-00); instruction manual (070-1128-01).

### TIMING HEAD CHARACTERISTICS

| | Bandwidth | Risetime | Application |
|---|---|---|---|
| S-51 | 1 GHz to 18 GHz trigger countdown | — | High Speed Sinewave Sampling |
| S-52 | — | ≤25 ps | High Resolution TDR |
| S-53 | Dc to 1 GHz trigger recognizer | — | General Purpose Sampling |
| S-54 | — | ≤1 ns | Medium Resolution TDR |

## S-51

**18 GHz Countdown**

**10 ps or Less Trigger Jitter**

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of sinewaves from 1 GHz to 18 GHz. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

**Input Signal** — Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p maximum.

**Input Characteristics** — 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

**Trigger Output** — Front-panel trigger output is at least 200 mV into 50 Ω, BSM type connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less; kickout occurs between successive samples.

**Weight** — Net: 0.5 kg (1.0 lb). Shipping: 2.3 kg (5.0 lb).

### ORDERING INFORMATION

**S-51** Trigger Countdown Head **$1,655**

**Includes:** Instruction manual (070-0898-00).

## S-52

**25 ps Risetime**

**200 mV into 50 Ω**

**50 Ω Source**

**Pretrigger Output**

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution TDR (Time Domain Reflectometer). For TDR applications, it features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 250 ft in any cable. A pretrigger output allows operation in sequential sampling systems without a delay line.

**Pulse Output —** Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration when used with the 7S12 in the TDR mode is typically 750 ps. Pulse duration when powered by the 7S11 is >800 ns. Pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

**Pretrigger Output —** Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

**Output Connectors —** Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

**Weight —** Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

### ORDERING INFORMATION

**S-52** Pulse Generator Head **$1,920**

**Includes:** 1 ns, 50 Ω semirigid coax delay line (015-1023-00); instruction manual (070-1101-01).

## S-53

**Dc-to-1 GHz Operation**

**10 mV Sensitivity**

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

**Input Characteristics —** Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

**Output Characteristics —** Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less.

**Connectors —** Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

**Weight —** Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

### ORDERING INFORMATION

**S-53** Trigger Recognizer Head **$1,390**

**Includes:** 42 inch, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); instruction manual (070-1147-00).

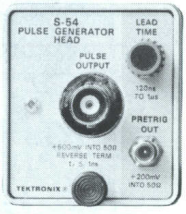
## S-54

**1 ns Risetime**

**Low Aberrations**

**400 mV into 50 Ω**

**Variable Pretrigger Lead Time**




The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line TDR unit.

For TDR applications, it S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows operation in sequential sampling systems without a delay line.

**Pulse Output —** Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base line level is 0 V within 20 mV, terminated in 50 Ω.

**Pretrigger Output —** Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

**Output Connectors —** Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

**Weight —** Net: 0.3 kg (0.8 lb). Shipping: 0.5 kg (1.0 lb).

### ORDERING INFORMATION

**S-54** Pulse Generator Head **$1,335**

**Includes:** BNC T connector (103-0030-00); 8 inch 50 Ω cable (012-0118-00); instruction manual (070-1093-00).

### OPTIONAL SAMPLING ACCESSORIES

**CT-1 Current Transformer —** With GR Cable. Order 015-0041-00 **$175**

**P6056 10X Passive Probe —** Order 010-6056-03 **$185**

**P6057 100X Passive Probe —** Order 010-6057-03 **$190**

**Coupling Capacitor, GR874-K —** Order 017-0028-00 **$100**

**Power Divider GR874-TPD —** Order 017-0082-00 **$375**

**GR to BNC Adaptor —** Order 017-0063-00 **$43**

**Probe Tip-to-BNC Adaptor —** Order 013-0084-01 **$8.00**

**Probe Tip-to-GR Adaptor —** Order 017-0076-00 **$55**

**Probe Tip-to-GR Terminated Adaptor —** Order 017-0088-00 **$50**

### OPTIONAL SAMPLING HEAD ACCESSORIES

**With SMA (3 mm) Connectors**

**2X 50 Ω Attenuator** — Order 015-1001-00 **$120**

**5X 50 Ω Attenuator** — Order 015-1002-00 **$120**

**10X 50 Ω Attenuator** — Order 015-1003-00 **$120**

**50 Ω Termination** — Order 015-1004-00 **$60**

**2 ns 50 Ω Signal Cable —** Order 015-1005-00 **$90**

**5 ns 50 Ω Signal Cable —** Order 015-1006-00 **$140**

**Female-to-GR874 Adaptor —** Order 015-1007-00 **$100**

**Male-to-GR874 Adaptor —** Order 015-1008-00 **$100**

**Male-to-N Female Adaptor —** Order 015-1009-00 **$25**

**Male-to-7 mm Adaptor —** Order 015-1010-00 **$175**

**Male-to-Male Adaptor** — Order 015-1011-00 **$20**

**Female-to-Female Adaptor —** Order 015-1012-00 **$9.25**

**Coupling Capacitor** — Order 015-1013-00 **$200**

**50 Ω Power Divider T** — Order 015-1014-00 **$200**

**500 ps 50 Ω Semi-rigid Cable —** Order 015-1015-00 **$25**

**SMA T Adaptor** — Order 015-1016-00 **$35**

**SMA Male-to-BNC Female Adaptor —** Order 015-1018-00 **$8.00**

**1 ns 50 Ω Cable** — Order 015-1019-00 **$120**

**SMA Male Short-Circuit Termination —** Order 015-1020-00 **$17.50**

**SMA Female Short-Circuit Termination —** Order 015-1021-00 **$24**

**SMA Male 50 Ω Termination —** Order 015-1022-00 **$32**

**With 50 Ω BNC Connectors**

**Feed-through Termination —** Order 011-0049-01 **$25**

**Feed-through (5 W)** — Order 011-0099-00 **$40**

**2X Attenuator** — Order 011-0069-02 **$35**

**2.5X Attenuator** — Order 011-0076-02 **$35**

**5X Attenuator** — Order 011-0060-02 **$35**

**10X Attenuator** — Order 011-0059-02 **$35**

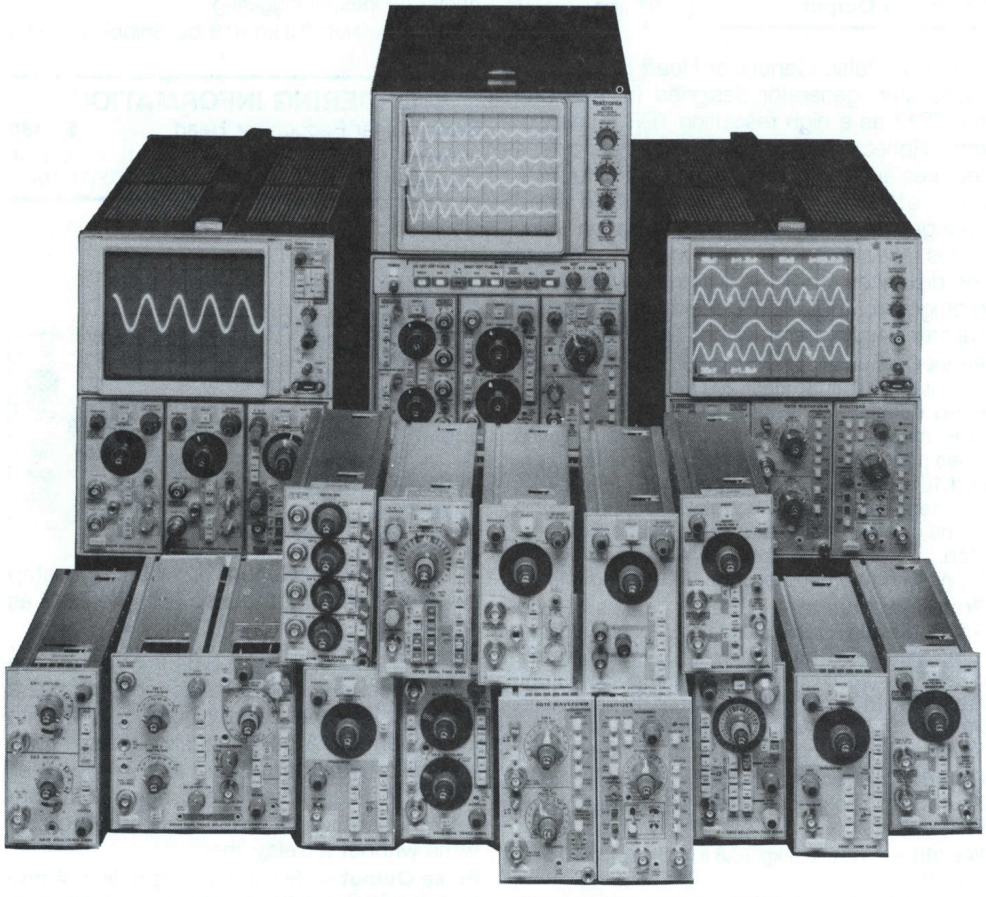
**18 in, Coaxial Cable** — Order 012-0076-00 **$17**

**42 in, Coaxial Cable** — Order 012-0057-01 **$17**

# 5000 SERIES INSTRUMENTS

## CONTENTS


5000 Series Storage Mainframes ..... 241, 244
5000 Series Nonstorage Mainframes .... 241, 244
5000 Series Color Oscilloscope ..... 246
5000 Series Plug-ins ..... 242, 243, 247-252
5000 Series Digitizing Oscilloscope ..... 328

- **Low Cost**
- **Seven Oscilloscope Models**
- **2 MHz, 10 MHz or 50 MHz Bandwidth**
- **10 μV/Div Sensitivity**
- **Sampling to 1 GHz**
- **Wide Choice of Plug-Ins**
- **One to Eight Trace Capability**
- **Color, Digital, Dual-Beam & Storage Displays**
- **Large 6.5 Inch CRT (8 x 10 Div)**
- **CRT Readout (5400 Series and 5D10)**
- **Delayed-Sweep Time Bases**
- **Y-T or X-Y Operation**
- **Bench-to-Rack Convertibility**

The 5000 Series plug-in oscilloscope family is designed to provide maximum versatility and performance at the lowest possible price.

The seven 5100 Series mainframes provide realtime bandwidth to 2 MHz, sampling bandwidth to 1 GHz, sensitivity to 10 microvolts per division, CRT and digital storage, dual sweep operation, and more. The 5116, with the 5D10 digital storage, provides multicolor display of multitrace signals, scale factor readout, and cursor measurements.

### 5000 SERIES SELECTION GUIDE

| | 5440/R5440 Nonstorage with Readout | 5441/R5441 Variable Persistence Storage with Readout | 5110/R5110 Nonstorage | 5111A/R5111A Bistable Storage | 5113/R513 Dual Beam Bistable Storage | 5116 Nonstorage Color*1 |
|---|---|---|---|---|---|---|
| **Bandwidth*2** | 50 MHz | 50 MHz | 2 MHz | 2 MHz | 2 MHz | 2 MHz |
| **Minimum Deflection Factor** | 5 mV/div at BW<br>10 μV/div<br>0.5 mA/div | 5 mV/div at BW<br>10 μV/div<br>0.5 mA/div | 1 mV/div at BW<br>10 μV/div<br>0.5 mA/div | 1 mV/div at BW<br>10 μV/div<br>0.5 mA/div | 1 mV/div at BW<br>10μV/div<br>0.5 mA/div | 1 mV/div at BW<br>10μV/div<br>0.5 mA/div |
| **Maximum Sweep Rate** | 5 ns | 5 ns | 100 ns | 100 ns | 100 ns | 100 ns |
| **Eight Traces** | ✔ | ✔ | ✔ | ✔ | ✔<br>Dual Beam | ✔ |
| **Delayed Sweep** | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Page** | 241 | 241 | 244 | 244 | 244 | 246 |
| **Prices*3 Begin at** | $3,160/$3,225 | $5,245/$5,300 | $1,650/$1,720 | $2,700/$2,765 | $4,005/$4,135 | $2,460 |

**1 The 5116 must be used with 5D10 to obtain color display.*
**2 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.*
**3 Price does not include plug-ins.*

The 5223 digitizing mainframe with the 5B25N time base provides digitization of signals to 10 MHz with optional GPIB interface.

The 5400 Series mainframes provide all of the capabilities of the 5100 Series mainframes plus 50 MHz bandwidth, variable persistence storage, and CRT readout of vertical and horizontal scale factors.

## 5100 SERIES OSCILLOSCOPES

Four 5100 Series oscilloscope mainframes are available: the 5110 single-beam nonstorage mainframe, the 5111A single-beam storage mainframe, the 5113 dual-beam storage mainframe, and the 5116 single-beam nonstorage mainframe with color shutter. All of these mainframes feature 2 MHz vertical systems with large 6½ inch CRTs.

Each of the 5000 Series mainframes houses up to three plug-in units. For conventional Y-T operation, the left and middle plug-ins are amplifier units and the right plug-in is a time base unit. An amplifier unit may be used in the right-hand plug-in compartment to provide X-Y operation to the full sensitivity of the amplifier unit used. A dual-trace amplifier unit in the right-hand compartment can provide fully independent dual X-Y displays.

When used with the 5D10 Waveform Digitizer, the 5116 mainframe provides a unique three color display, with scale factor and cursor readouts, in addition to the digital storage capabilities of the 5D10.

Detailed descriptions of the 5100 Series mainframes and plug-ins start on page 244.

## 5223 DIGITIZING OSCILLOSCOPE

You can get the benefits of digital storage, along with the time-tested advantages of a conventional analog scope, in the 10 MHz 5223 Digitizing Oscilloscope. Combined in one powerful, convenient oscilloscope are pushbutton ease, high quality waveform display, pretrigger signal manipulation, and optional GPIB interface, plus real-time analog display capability.

Use the 5223 in the digital storage mode to capture repetitive events up to 10 MHz in frequency or single-shot events up to 100 kHz in frequency. The maximum sample rate is 1 MHz; storage capacity is 1024 bits per vertical compartment.

The digitized display will never fade or bloom, so you get more accurate measurements, more conveniently. High 10-bit vertical resolution gives you an accurate representation of your signals.

For further information on the 5223 Digitizing Oscilloscope and its associated 5B25N time base unit, see page 328 in the Digitizer Section.

## 5400 SERIES OSCILLOSCOPES

Two 5400 Series display units are presently available: A single-beam, nonstorage display and a variable persistence storage display. Both feature CRT readout of plug-in scale factors, three plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series offers 50 MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be externally accessed (Option 03). Detailed descriptions of the 5400 Series mainframes and associated plug-ins start on page 241.

## PLUG-IN VERSATILITY

A wide choice of plug-ins is available in the 5000 Series family. All these plug-ins are compatible with the 5400 Series, and most are compatible with 5100 Series mainframes. Compatibility of 5000 Series mainframes and plug-ins are shown in the chart below.

The amplifier plug-ins include single, dual, and four trace units, and various differential amplifiers. The time base plug-ins include single, dual, and delaying sweep units, and a digital time base.

## 5000 SERIES MAINFRAME/PLUG-IN COMPATABILITY

F=Full Compatability  L=Limited Compatability  0=No Compatability

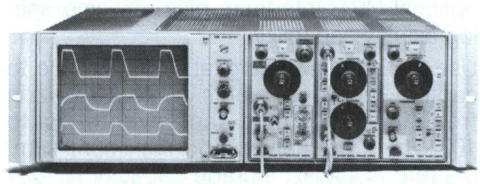
| Plug-ins | 5110 2 MHz Nonstorage | 5111A 2 MHz CRT Storage | 5113 2 MHz Dual Beam CRT Storage | 5116 2 MHz Nonstorage with Color*1 | 5223 10 MHz Digital Storage | 5440 50 MHz Nonstorage w/ Readout | 5441 50 MHz Variable Persistence w/ Readout | Page | Prices |
|---|---|---|---|---|---|---|---|---|---|
| **5A14N** Four Trace, 1 MHz, 1 mV/div | F | F | F | L*1 | F | L*2 | L*2 | 248 | $1,620 |
| **5A15N** Single Trace, 2 MHz, 1 mV/div | F | F | F | L*1 | F | L*2 | L*2 | 248 | $390 |
| **5A18N** Dual Trace, 2 MHz, 1 mV/div | F | F | F | L*1 | F | L*2 | L*2 | 248 | $815 |
| **5A19N** Single Trace Differential, 2 MHz, 1 mV/div | F | F | F | L*1 | F | L*2 | L*2 | 249 | $470 |
| **5A21N** Single Trace Differential, 1 MHz, 50 μV/div, 0.5 mA/div | F | F | F | L*1 | F | L*2 | L*2 | 249 | $600 |
| **5A22N** Single Trace Differential, 1 MHz, 10 μV/div | F | F | F | L*1 | F | L*2 | L*2 | 250 | $1,190 |
| **5A26** Dual Trace Differential, 1 MHz, 50 μV/div | F | F | F | L*1 | F | F | F | 250 | $1,305 |
| **5A38** Dual Trace, 35 MHz, 10 mV/div | 0 | 0 | 0 | 0 | F | F | F | 242 | $765 |
| **5A48** Dual Trace, 50 MHz, 1 mV/div | 0 | 0 | 0 | 0 | F | F | F | 243 | $1,140 |
| **5B10N** Single Sweep Time Base/ Amplifier, 1 μs to 5 s | F | F | F | L*1 | L*3 | L*2 | L*2 | 251 | $585 |
| **5B12N** Dual Sweep Time Base, A–1 μs to 5 s, B–2 μs to 0.5 s | F | F | F | L*1 | L*3 | L*2 | L*2 | 251 | $1,230 |
| **5B25N** Digital Time Base for 5223, 0.2 μs to 5 s | 0 | 0 | 0 | 0 | F | L*2 | L*2 | 329 | $970 |
| **5B40** Single Sweep Time Base, 0.1 μs to 5 s | 0 | 0 | 0 | 0 | L*3 | F | F | 243 | $790 |
| **5B42** Delaying Time Base, A–0.1 μs to 5 s, B–0.1 μs to 0.5 s | 0 | 0 | 0 | 0 | L*3 | F | F | 243 | $1,435 |
| **5CT1N** Semiconductor Curve Tracer | F | F | F | L*1 | F | L*2 | L*2 | 252 | $1,050 |
| **5D10** Waveform Digitizer | F*1 | F*1 | F*1 | F | L*1*3 | F*1 | F*1 | 247 | $2,045 |
| **5S14N** 1 GHz Sampling Units | F | F | F | L*1 | F | L*2 | L*2 | 252 | $6,355 |

*1 *The 5116 must be used with 5D10 to obtain color display.*
*2 *Plug-ins with an "N" suffix do not implement the readout feature of the 5440 and 5441.*
*3 *Only 5B25N implements the digital storage feature of the 5223.*

Three special-purpose plug-ins are also available. The 5CT1N is a semiconductor curve tracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the CRT. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of the 5100, the 5400 Series, and the 5223 to 1 GHz at 2 mV sensitivity.

The 5D10 is a dual channel digital storage unit with cursors, CRT scale factor readout, roll mode and plotter output.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and/or the recommended 1X and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the CRT when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.



*5000 Series rackmount oscilloscopes and cabinet-to-rackmount kits include complete slide out tracks and mounting hardware interface with standard 19 inch racks.*

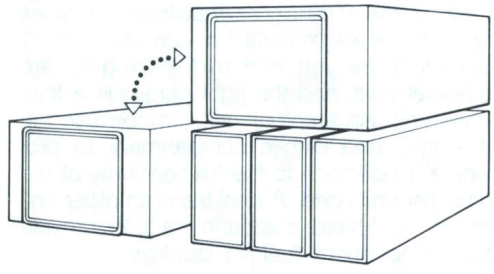
**CONVERSION KITS**

**Cabinet-to-Rackmount**
Order 040-0583-03 **$155**

**Rackmount-to-Cabinet**
Order 040-0584-04 **$180**

**Rackmount-to-Cabinet (R5223 Only)**
Order 040-0975-01 **$275**

**Cabinet-to-Rackmount (5223 Only)**
Order 040-0976-04 **$375**



**CARTS**

**SCOPE-MOBILE® Carts —** For cabinet models. Order Lab Instrument Cart, K213.

**CAMERAS**

**C-5C or C-4 Option 02 —** For all 5100 Series. Suitable for repetitive or stored traces.

**C-59A (G or P) —** General Purpose. For 5100 Series Storage scopes, 5440 (P back), 5441 (G back).

**For full details see camera section on page 404.**

**OPTIONAL ACCESSORIES**

**Blank Plug-in Kit —** Order 040-0818-03 **$105**

**Blank Panel —** Order 016-0195-03 **$25**

**Viewing Hoods —**
Order 016-0154-00 **$35**
Order 016-0452-00 (Folding) **$21**

**Protective Cover —** Order 016-0544-00 **$18**

**For full details see accessories section on page 403.**

## 5000 SERIES PLUG-IN/PROBE COMPATIBILITY

| Plug-in | Probe | Attenuation | Features |
|---|---|---|---|
| 5A14N<br>5A15N<br>5A18N<br>5D10 | P6101A<br>P6102A<br>P6062B | 1X<br>10X<br>1X-10X | Full bandwidth<br>Full bandwidth<br>Switchable attenuation, ground-reference button |
| 5A21N<br>5A22N<br>5A26 | P6101A<br>P6102A<br>P6062B<br>P6055 | 1X<br>10X<br>1X-10X<br>10X | Full bandwidth<br>Full bandwidth<br>Switchable attenuation, ground-reference button<br>Variable attenuation for high CMRR in differential operation. |
| 5A38<br>5A48 | P6101A<br>P6105A<br>P6062B | 1X<br>10X<br>1X-10X | Reduced bandwidth<br>Full bandwidth<br>Switchable attenuation, ground-reference button, reduced bandwidth at 1X. |

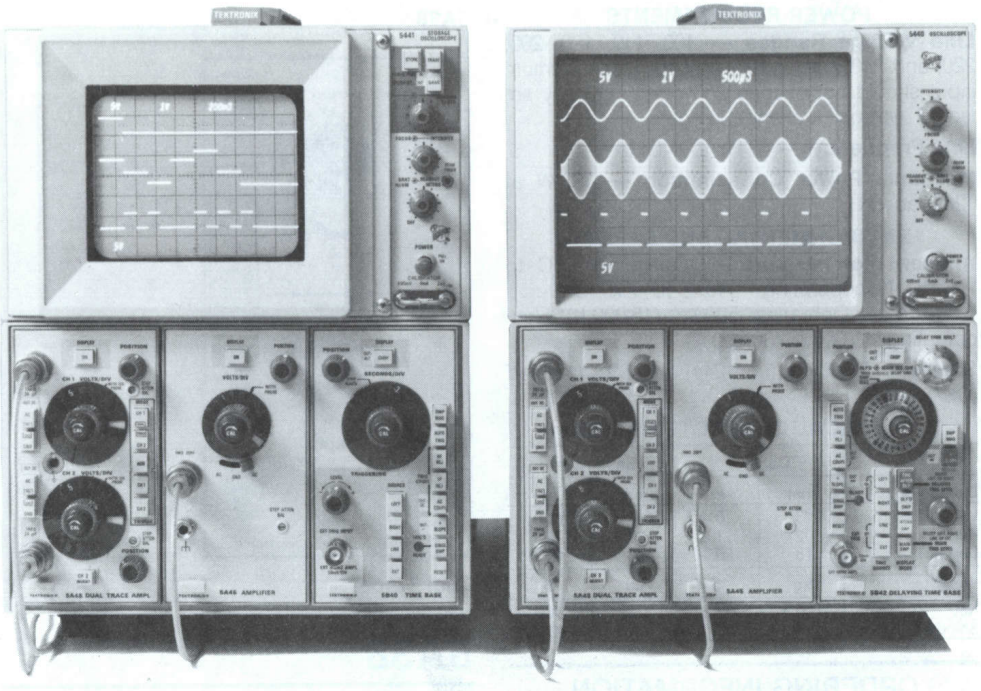
**See Probe section for complete descriptions, page 425.**

## 5000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

| | 5223 | | | | 5100 and 5400 Series | | | | Plug-ins | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cabinet | | Rackmount | | Cabinet | | Rackmount | | Single Width | | Double Width | |
| **Dimensions** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 213 | 8.4 | 483 | 19.0 | 213 | 8.4 | 483 | 19.0 | 66 | 2.6 | 132 | 5.2 |
| Height | 328 | 12.9 | 178 | 7.0 | 302 | 11.9 | 133 | 5.3 | 127 | 5.0 | 127 | 5.0 |
| Depth | 572 | 22.5 | 569 | 22.4 | 518 | 20.4 | 483 | 19.0 | 305 | 12.0 | 305 | 12.0 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 16.9 | 37.3 | 19.1 | 42.0 | 10.4 | 23.0 | 10.9 | 24.0 | 1.3 | 2.8 | 2.6 | 5.8 |
| Shipping | 20.5 | 45.0 | 23.6 | 52.0 | 14.5 | 32.0 | 19.5 | 43.0 | 4.5 | 10.0 | 4.9 | 10.8 |

## CURRENT APPLICATION NOTES FOR 5000 SERIES

| Title | Featuring | Request Number |
|---|---|---|
| BIOPHYSICAL DATA RETRIEVAL, The Digitizing Approach | 5223/5B25N/5A18N Roll mode, chart recorder output. | W-4462-1 |
| INTERPRETING MECHANICAL MEASUREMENTS WITH THE PLUG-IN OSCILLOSCOPE | 5111/5A22N/5A18N Transducer measurements and storage. | A-3533-1 |
| SIMULTANEOUS DISPLAY OF TWO INDEPENDENT X-Y SIGNAL PAIRS | 5111/5A15/5A15N/5A18N. Dual X-Y techniques, engine analysis. | AX-4114 |
| SIMULTANEOUS X-Y, Y-T DISPLAYS | 5111/5A15/5A15N/5B12N. X-Y, Y-T techniques. Biomedical application. | AX-4113 |
| CUSTOM PLUG-IN IDEAS FOR 5000 SERIES SCOPES | Recommended starter note for customers considering custom plug-in project. | AX-3758 |
| A HIGH RESOLUTION 60 Hz NOTCH FILTER | Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum. | AX-4031 |
| A TRUE RMS CONVERTER | Construction project using thermal true RMS converter module in our blank plug-in kit. Measures true RMS up to 200 V RMS. | AX-4112 |



## 5440/R5440 General Purpose
## 5441/R5441 Storage

- Dc to 50 MHz
- Sampling to 1 GHz
- 5 div/μs Stored Writing Speed (5441/R5441)
- Variable Persistence Storage (5441/R5441)
- CRT Readout
- 3 Plug-in Flexibility
- Wide Choice of Plug-ins
- Bench to Rack Convertibility
- Low Cost

### TYPICAL APPLICATIONS (5440/R5440)

- ✱ Electrical Engineering
- ✱ Component Testing
- ✱ Ultrasonics

### TYPICAL APPLICATIONS (5441/R5441)

- ✱ Ultrasonics
- ✱ Low Power Laser
- ✱ Fiber Optics

See page 240 for available Application Notes.

The 5440 and 5441 combine versatility and low cost in a 50 MHz (1 GHz with 5S14N dual trace sampling unit) general-purpose, plug-in oscilloscope. They feature CRT readout of plug-in scale factors, sensitivities to 10 microvolts per division, display of up to eight different signals at two different sweep rates, a three plug-in mainframe, a wide choice of plug-ins and bench to rack convertibility.

Plug-in scale factors are displayed on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. The CRT readout can also be accessed externally to allow the display of dates, times, test numbers, etc., along with displayed waveforms. (Order Option 03 User Addressable CRT Readout).

The variable persistence of the 5441 provides the ideal means of viewing hard-to-observe signals such as fast single-shot transients and very low frequency phenomena that require a very slowly moving trace on the CRT. It may be used to completely eliminate the flicker inherent in low-rep-rate traces. With the 5441, the viewing time at normal intensity for any trace can be varied from a fraction of a second to more than five minutes. At lowered intensity (SAVE mode), signals may be viewed for up to an hour.

In addition to permitting convenient viewing of single-shot and low frequency phenomena, the variable persistence of the 5441 may also be used to suppress the random noise that obscures the true waveform in signals with low signal-to-noise ratio.

The 5441 is especially useful for looking at very low-rep rate signals with the 5S14N 1 GHz sampling plug-in unit. In that application, the sample-by-sample development of a complete waveform on the CRT screen can take several seconds or even minutes, if the signal repetition rate is very slow. The variable persistence allows all samples to remain on screen until the entire waveform has been developed.

All the plug-ins in the 5000 Series are compatible with the 5440 and 5441.*[1]

The wide variety of plug-ins allows oscilloscope/plug-in configuration to meet your current and future needs: from a single-trace, single time-base configuration for production monitoring, to four-trace, delayed sweep for logic work, to four-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

*[1] *Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout. The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

## CHARACTERISTICS

### VERTICAL SYSTEM

The following characteristics are for both the 5440/R5440 and 5441/R5441 unless otherwise indicated.

**Channels** — Left and center plug-in compartments. Compatible with all 5000 Series plug-ins. CRT readout is not available with plug-ins having a suffix N (5A18N, etc.).

**Bandwidth** — Up to 50 MHz, determined by plug-in unit. See page 237.

**Deflection Factor** — Determined by plug-in unit. See page 237.

**Chopped Mode** — The oscilloscope will chop between channels at ≈25 kHz to 100 kHz, depending on plug-ins and operating modes.

**Alternate Mode** — Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment. Compatible with all 5000 Series plug-ins. CRT readout is not available for plug-ins with a Suffix N (5B10N, etc.).

**Internal Trigger Mode** — Left vertical, right vertical.

**Fastest Calibrated Sweep Rate** — 10 ns/div, determined by plug-in.

**X-Y Mode** — Phase shift is within 2° from dc to 20 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — 5440/R5440: Internal parallax-free 8 x 10 div (1.22 cm/div) illuminated graticule. Accelerating potential is 15 kV with GH (P31) phosphor standard. 5441/R5441: Internal, parallax-free, 8 x 10 div (0.9 cm/div) illuminated graticule. Accelerating potential is 8.5 kV. GH (P31) phosphor standard.

**Autofocus** — Reduces the need for manual focusing with changes in intensity after focus control has been set.

**External Intensity Input** — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range is dc to 2 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

**Beam Finder** — Brings offscreen into graticule area.

### 5440/R5440 FEATURES

**Minimum Photographic Writing Speed** — Using Polaroid film 20,000 ASA without film fogging. Writing speed can be increased with the Tektronix Writing Speed Enhancer. (See page 410 for more information.)

| Writing Speed cm/μs | | | | Camera | Lens |
|---|---|---|---|---|---|
| GH (P31) Phosphor | | BE (P11) Phosphor | | | |
| 20,000 ASA | 3000 ASA | 20,000 ASA | 3000 ASA | | |
| 180 | 90 | 245 | 125 | C-59P | f/2.8 0.67 mag |
| 330 | 160 | 450 | 230 | C-50P*[1] | f/1.9 0.7 mag |

*[1] *Slight cropping of the graticule corners. Requires optional battery pack (016-0270-02) for operation with the 5440.*

**Optional Phosphors (Specify)** — GM (P7) or BE (P11).

### 5441/R5441 FEATURES

**Persistence** — Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

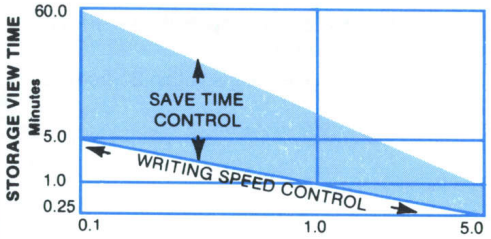
**Maximum Stored Writing Speed** — Writing speed >5 div/μs for a view time of 15 s.

**Storage View Time** — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 seconds with the writing speed control fully cw. Adjusting the stored instensity ccw will reduce the stored writing speed, but view time can be increased up to five minutes (refer to chart below).

**Save Mode** — Extends view time of stored displays up to one hour; prevents erasure of stored display and storage of unwanted displays.

**Erase Time** — 0.5 s ±10%.




**STORED WRITING SPEED (Div/μs at Maximum Persistence)**

### CALIBRATOR

**Voltage** — 400 mV within 1%.

**Current Output** — 4 mA within 1%. Frequency is two times the line frequency.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 100 W at 120 V ac. 60 Hz.

### ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −40°C to +70°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 213 | 8.4 | 483 | 19.0 |
| Height | 302 | 11.9 | 133 | 5.3 |
| Depth | 518 | 20.4 | 483 | 19.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 10.4 | 23.0 | 10.9 | 24.0 |
| Shipping | 14.5 | 32.0 | 19.5 | 43.0 |

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**5440** Oscilloscope — **$3,160**
**Includes:** Instruction manual (070-2139-01).

**R5440** Rackmount Oscilloscope — **$3,225**
**Includes:** Same as 5440.

**5441** Oscilloscope — **$5,245**
**Includes:** Instruction manual (070-2140-01).

**R5441** Oscilloscope (Rackmount) — **$5,300**
**Includes:** Same as 5441.

**OPTIONS (5440/R5440 and 5441/R5441)**

**Option 01** — Without CRT Readout. **−$280**

**Option 03** — User Addressable CRT Readout. Up to 20 user-selected characters may be displayed in the CRT readout for additional test information such as time, date, device tested, test number, etc. Especially useful for documenting photographs. Programming of characters is done by external resistors and switches. **+$150**

**Option 04** — (5440/5441 only) Protective Panel Cover. **+$40**

**Option 76** — (5440/R5440 only) GM (P7) Phosphor. **+$50**

**Option 78** — (5440/R5440 only) BE (P11) Phosphor **+$50**

**CONVERSION KITS (5440/R5440 and 5441/R5441)**

**CRT Readout** — Order 040-0691-02 **$550**

**Cabinet-to-Rackmount** — Order 040-0583-03 **$155**

**Rackmount-to-Cabinet** — Order 040-0584-04 **$180**

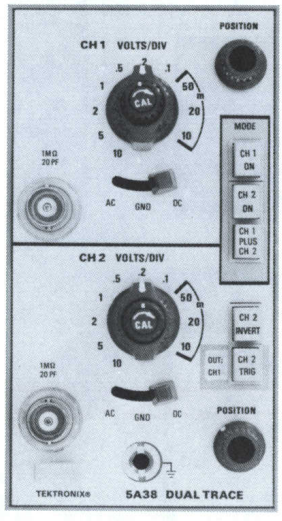
**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10,1,50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.

### OPTIONAL ACCESSORIES

**Recommended Plug-ins** — See page 239.
**Recommended Probes** — See pages 239 and 426.
**Recommended Cameras** — See page 406.

**5A38**




**Dual Trace**

# 5A38

**Dc to 35 MHz Bandwidth**

**10 mV/div to 10 V/div Calibrated Deflection Factors**

The 5A38 is a dual trace, 35 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. It features 10 mV/div sensitivity and CRT readout of deflection factor.*[1]

## CHARACTERISTICS

**Bandwidth** — Dc Coupled: To ⩾35 MHz. Lower End Response, Ac Coupled: ⩽10 Hz.

**Deflection Factors** — Calibrated: 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: is ⩽3% from 15°C to 35°C, 4% from 0°C to +50°C. Uncalibrated: Variable is continuous between steps to at least 25 V/div.

**Input R and C** — 1 MΩ paralleled by ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum at 1 kHz or less.

**Stability** — ⩽0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ⩽0.2 mV/°C vertical shift with line voltage held constant.

**Display Modes** — Channel 1 only, Channel 2 only (normal or inverted), Dual Trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from Channel 1 or Channel 2.

**Risetime** — ⩽10 ns.

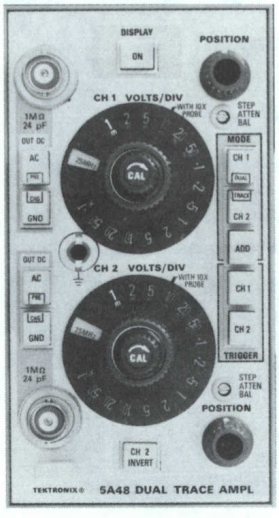
**Channel Isolation** — ⩾50:1 to 35 MHz with both traces displayed.

## ORDERING INFORMATION

**5A38** Dual Trace Amplifier — **$765**
**Includes:** Instruction manual (070-1694-00).
For floating measurements, order A6902B Isolator. See page 437 for complete description.

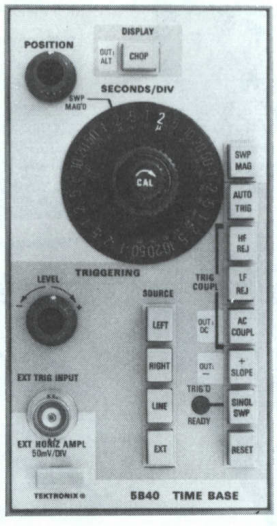
*[1] *CRT readout not functional in 5223.*

5A48



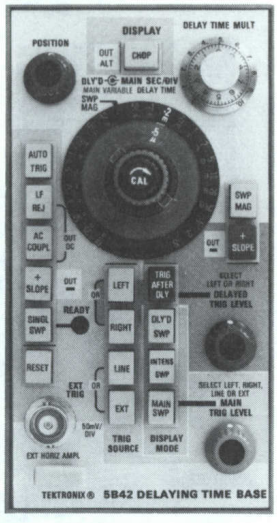

Dual Trace

5B40




Time Base

5B42




Delaying Time Base

# 5A48

## Dc to 50 MHz Bandwidth

## 1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A48 is a dual trace 50 MHz plug-in amplifier for use in the 5223 and the 5400 Series mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.*1

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 50 MHz at 5 mV/div to 10 V/div, dc to at least 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac coupled: 10 Hz or less (1 Hz with 10X probe) at all deflection factors (3 dB down).

**Deflection Factors** — Calibrated: 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy: ≤5% at 1 mV/div and 2 mV/div; ≤3% from 5 mV/div to 10 V/div from +15°C to +35°C; ≤4% from 5 mV/div to 10 V/div from 0°C to +50°C. Uncalibrated: Variable is continuous between steps to at least 25 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈24 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac. Ac Coupled: 500 V (dc + peak ac). Ac Component: 500 V p-p maximum, 1 kHz or less.

**Stability** — ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

*1 *CRT readout not functional in 5223.*

For recommended probes see pages 240 and 426.

**Display Modes** — Channel 1 only, Channel 2 only (normal or inverted), Dual trace, Added, Alternated, Chopped (determined by time base plug-in horizontal compartment). Internal Trigger Source: Selectable from Channel 1 or Channel 2.

**Risetime** — 7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

### ORDERING INFORMATION

**5A48** Dual Trace Amplifier **$1,140**
**Includes:** Instruction manual (070-1450-00).
For floating measurements, order A6902B Isolator. See page 437 for complete description.

# 5B40/5B42

## Single Sweep

## 10 ns/div to 5 s/div Calibrated Time Base

## Triggering to 50 MHz

The 5B40/5B42 Time Bases are designed for use in 5400 Series mainframes. They feature sweep rates from 10 ns/div to 5 s/div and CRT readout of the sweep rate selected. The 5B42 also features delayed sweep rates up to 10 ns/div.

### CHARACTERISTICS

The following characteristics are the same for the 5B40 and 5B42 unless otherwise noted.

**Sweep Rate** — 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

**Sweep Accuracy** — Measured in 5400 Series oscilloscope over center eight graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

| | Unmagnified | | Magnified | |
|---|---|---|---|---|
| Time/Div | +15°C to +35°C | 0°C to +50°C | +15°C to +35°C | 0°C to +50°C |
| 1 s/div to 0.5 μs/div | 3% | 4% | 4% | 5.5% |
| 5 s/div and 2 s/div, 0.2 μs/div and 0.1 μs/div | 4% | 5% | 5% | 6.5% |

### TRIGGERING

**Triggering Sensitivity**

| Coupling | Frequency Range | Minimum Signal Required | |
|---|---|---|---|
| | | Internal | External |
| Dc 5400 ampl | Dc to 10 MHz | 0.4 div*1 | 60 mV*1 |
| | | 0.4 div*2 | 100 mV*2 |
| 5400 ampl | 10 MHz to 60 MHz | 1.0 div*1 | 150 mV*1 |
| | | 1.0 div*2 | 400 mV*2 |
| 5100 ampl | Dc to 2 MHz | 0.4 div*2 | 100 mV*2 |
| Ac | Trigger requirements increase below 50 Hz | | |
| LF Rej | Trigger requirements increase below 7.5 kHz | | |
| HF Rej | Trigger requirements increase above 50 kHz*1 | | |

*1 *5B40 only.*
*2 *5B42 only.*

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

**Ext Trigger Input** — Maximum Input Voltage: 350 V dc + peak ac, 350 V p-p ac at ≤1 kHz. Input R and C: 1 MΩ paralleled by ≈24 pF. Trigger Level Range: ≥ ±1.5 V (5B40) and ±2.5 V (5B42).

**Ext Horizontal Input** — Deflection Factor: 50 mV/div ±3%. Input R and C: 1 MΩ paralleled by ≈24 pF. Dc Coupled Bandwidth: Dc to ≤2 MHz. Ac Coupled Lower Response: ≤50 Hz. Maximum Input Voltage: 350 V (dc + peak ac) or 350 V p-p ac at ≤1 kHz.

### DELAYING SWEEP (5B42 ONLY)

**Delay Time Multiplier Range** — 0.2 to 10 times the Time/Div setting.

**Differential Time Measurement Accuracy** — Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale of 1 s to 5 s delay time.

**Jitter** — <0.05% of the time represented by one division of delaying sweep selected.

### DELAYED SWEEP (5B42 ONLY)

**Sweep Rate** — 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.

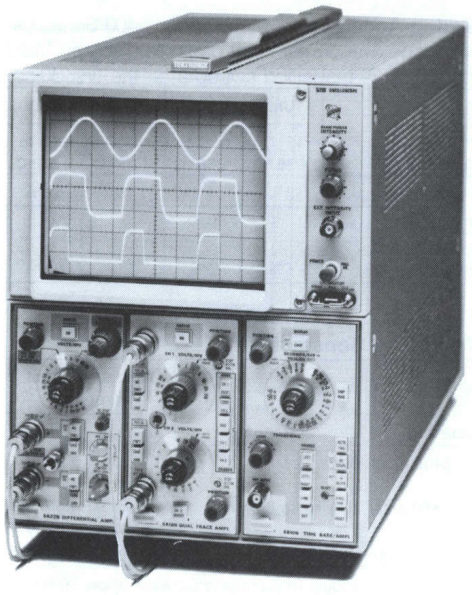
**Sweep Accuracy** — Measured over the center eight division. Same as undelayed sweep.

**Triggering** — The same as the internal triggering specifications in the table above.

### ORDERING INFORMATION

**5B40** Time Base **$790**
**Includes:** Instruction manual (070-1742-00).

**5B42** Delaying Time Base **$1,435**
**Includes:** Instruction manual (070-1447-00).



## 5100 Series Oscilloscopes

**Low Cost**

**Dc to 2 MHz**

**Sampling to 1 GHz**

**Wide Choice of Plug-ins**

**Rear Panel Signal Outputs Optional**

See page 238 for Application Notes.

## 5110/R5110

**Lowest Cost Single Beam Nonstorage Oscilloscope with Plug-in Configurability**

**8 Channels at 1 mV/div, 4 Channels at 50 μV/div, 2 Channels at 10 μV/div, with Appropriate Amplifiers**

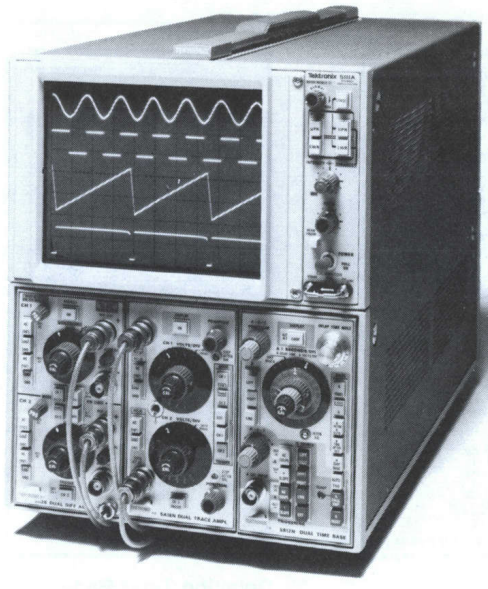
### TYPICAL APPLICATIONS

* **Biomedical Research**
* **Electro-Mechanical Design and Test**

The 5110 is a single beam nonstorage oscilloscope featuring a large diagonal 6½ inch (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from single-trace or dual-trace basic amplifiers and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and the 5B12N dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.



## 5111A/R5111A

**Single Beam Bistable Storage Oscilloscope**

**Split-Screen Display**

**Stored Writing Speed to 800 div/ms in Enhanced Mode (Option 03)**

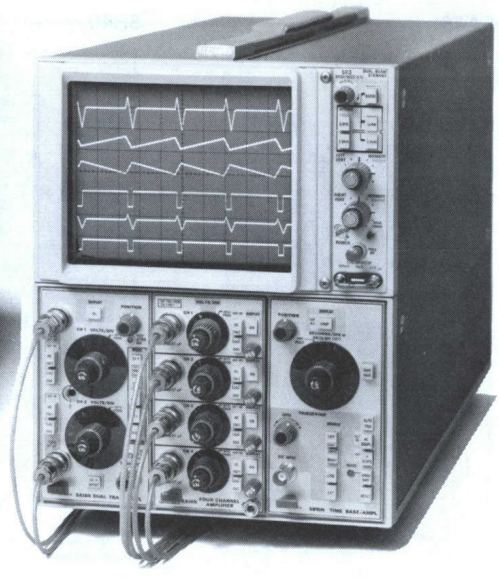
### TYPICAL APPLICATIONS

* **Electro-Mechanical Design and Test**
* **Vibration Analysis**

The 5111A is a single beam, split-screen, bistable storage oscilloscope with a large 6½ inch diagonal display. The 5111A extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography. It is particularly useful for recording low and medium frequency signals.

The standard 5111A provides writing speeds to 50 div/ms; option 03 extends the writing speed to 800 divisions per millisecond, suitable for capturing a single-shot display of a 60 kHz sinewave four divisions in amplitude.

Up to eight traces can be displayed and stored simultaneously, with two 5A14N amplifier plug-in units. When using two amplifiers and the 5B12N dual time base in the dual-sweep mode, the two sweeps are slaved individually to the two amplifiers.



## 5113/R5113

**Dual Beam Bistable Storage Oscilloscope**

**Split-Screen Dispaly**

**Two Independent Vertical Systems**

**Two Single-Shot Display Signals Display without Timesharing**

**Stored Writing Speed ⩾20 div/ms**

### TYPICAL APPLICATIONS

* **Biomedical Research**
* **Low Rep Rate Observation**

The 5113 is a dual beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms. View time is at least one hour at normal intensity and can be increased to ten hours at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. Both beams are driven by one set of horizontal deflection plates.

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be simultaneously observed and recorded.

## 5100 Series Oscilloscopes

### COMMON CHARACTERISTICS

These characteristics are for the 5110/R5110, 5111A/R5111A, 5113/R5113 and 5116 unless otherwise indicated.

### VERTICAL SYSTEM

**Channels** — Left and center plug-in compartments. Compatible with all 5100 Series plug-ins. See page 239.

**Bandwidth** — 2 MHz, determined by plug-in. See page 239.

**Deflection Factor** — Determined by plug-in. See page 239.

**Chopped Mode** — (5110/R5110, 5111A/R5111A, 5116) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≈5 μs, consisting of ≈4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

**Chopped Mode** — (5113/R5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≈5 μs, consisting of 4 μs displayed, ≈1 μs blanked. Chop or alternate mode is selected at the time base unit.

**Alternate Mode** — (5110/R5110, 5111A/R5111A, 5116) Each amplifier plug-in is swept twice before switching to the next. Single-trace amplifiers are swept twice. Each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

**Alternate Mode** — (5113/R5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment. Compatible with all 5100 Series plug-ins. See page 239.

**Fastest Calibrated Sweep Rate** — 0.1 μs/div (X10 mag) with 5B10N or 5B12N; 10 μs/div (10X mag) with 5D10.

**X-Y Mode** — Phase shift is within 1° from dc to 100 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 div (1.27 cm/div) parallax-free, nonilluminated graticule. Illuminated graticule available at extra cost. (Illuminated graticule standard on 5116.)

**Accelerating Potential** — 5110/R5110, 5111A/R5111A, 5113/R5113: 3.5 kV. 5116: 4.5 kV.

**Standard Phosphor** — 5110/R5110: GH (P31). 5111A/R5111A, 5113/R5113: Equivalent to GJ (P1).

**Optional Phosphors (Specify)** — (5110/R5110 only) GM (P7) or BE (P11).

**Beam Finder** — Aids in locating an off-screen signal.

**Maximum Stored Writing Speed** — (5111A and 5113 only) 5111A/R5111A: At least 20 div/ms in the Normal Mode and 50 div/ms in the Enhanced Mode. 5113/R5113: At least 20 div/ms.

**With Option 03, Fast Writing Speed CRT** — (5111A and 5113 only) At least 200 div/ms (center 6 x 8 div) in the Normal Mode and 800 divs/ms (center 6 x 8 div) in the Enhanced Mode.

**Storage View Time** — (5111A and 5113 Only) At least one hour at normal intensity; up to ten hours at reduced intensity, after which time it may be increased to original level.

**Erase Time** — (5111A and 5113 only) ≈250 ms.

### CALIBRATOR

**Voltage Output** — Squarewave, positive-going from ground.

**Voltage Range** — 400 mV within 1%.

**Current Output** — 4 mA with current loop. Frequency is two times the line frequency.

### OUTPUTS/INPUTS

**External Intensity Input** — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range is dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

### POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10% (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 110 W.

### ENVIRONMENTAL

**Ambient Temperature** — 5110/5111A/5113: Operating, 0°C to +50°C; nonoperating, −40°C to +70°C. 5116: Operating, 0°C to +45°C; nonoperating, −55°C to +75°C.

### PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 213 | 8.4 | 483 | 19.0 |
| Height | 302 | 11.9 | 133 | 5.3 |
| Depth | 518 | 20.4 | 483 | 19.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 10.4 | 23.0 | 10.9 | 24.0 |
| Shipping | 14.5 | 32.0 | 19.5 | 43.0 |

## Option 07

### Rear Panel Signal Outputs

### CHARACTERISTICS

**Left and Center Compartments** — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output impedance: 1 kΩ.

**Right Compartment** — Sweep: One BNC connector provides access to the CRT-related sweep waveform. Sensitivity is 0.5 V/CRT division; positive-going sawtooth, ⩾5 V. Output Impedance is 1 kΩ. Gate: One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

**X-Y Mode** — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**5110 Oscilloscope** — **$1,650**
**Includes:** Instruction manual (070-2134-01).

**R5110 Oscilloscope** — **$1,720**
**Includes:** Same as 5110.

**5111A Oscilloscope** — **$2,700**
**Includes:** Power cord (161-0066-00); instruction manual (070-3934-00).

**R5111A Oscilloscope** — **$2,765**
**Includes:** Same as 5111A.

**5113 Oscilloscope** — **$4,005**
**Includes:** Instruction manual (070-2137-01).

**R5113 Oscilloscope** — **$4,135**
**Includes:** Same as 5113.

**5116 Oscilloscope** — **$2,460**
**Includes:** Power cord (161-0066-00); instruction manual (070-4544-00).

**Option 02** — (5110, 5111A, 5113, 5116 only) Protective Panel Cover. The cover protects the front panel and knobs during transportation and storage. **+$40**

**Option 03** — (5111A/R5111A and 5113/R5113 only). Fast Write CRT increases stored writing speed to 200 div/ms (center 6 x 8 div). **+$150**

**Option 07** — Add Rear Panel Signals Out. **+$130**

**Option 76** — (5110, R5110 only) GM (P7) Phosphor. **+$50**

**Option 78** — (5110, R5110 only) BE (P11) Phosphor. **+$50**

### CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit** — Order 040-0583-03 — **$155**

**Rackmount-to-Cabinet Conversion Kit** — Order 040-0584-04 — **$180**

**Protective Panel Cover Kit** — (5110, 5111A, 5113, 5116 only). Order 040-0620-00 — **$38**

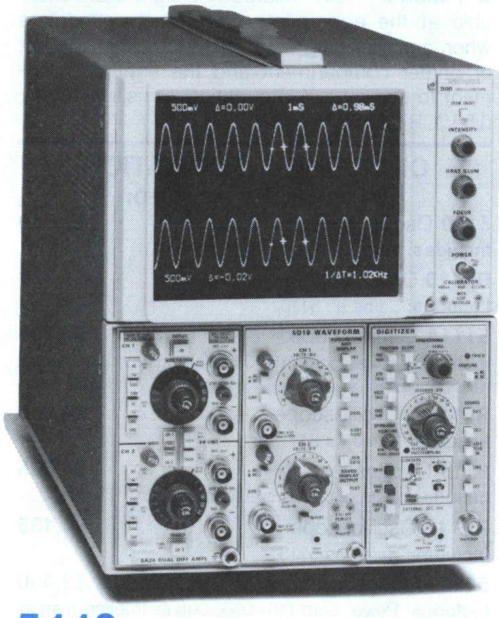
**Rear Panel Signal Outputs** — Order 040-0915-02 — **$230**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 , 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### OPTIONAL ACCESSORIES

**Recommended Plug-ins** — See page 239.
**Recommended Probes** — See pages 240 and 426.
**Recommended Cameras** — See page 406.



# 5116

**Three Color, High Resolution Digital Storage Display with 5D10**

**Convergence Not Required, Single Beam Design**

**Accepts Full Range of 5100 Series Amplifiers for Preconditioning or Noncolor Applications**

The 5116 Oscilloscope, when used with the 5D10 digital storage plug-in unit, provides a unique three-color display of the digital storage capabilities and features of the 5D10.

Color enhances individual trace and readout identification, thereby providing a much improved user interface. The coding capabilities afforded by color allow for interpretation and differentiation of data more quickly, reduced measurement time, fewer errors, and improved resolution by using the full screen for overlapping signals. See page 45 for a color photo of the 5116 with the 5D10.

Permanent color records may be obtained with either a Tektronix camera (see pages 403-416) or with the 5D10 plotter output.

The 5D10 occupies the center and right plug-in compartments of the mainframe with which it is used. The left-hand plug-in compartment may be used to house an additional 5100 Series amplifier plug-in whose signal may be displayed through the unique Channel 2 left plug-in display capability of the 5D10. In this mode of operation, the signal from the additional amplifier plug-in unit is digitized and displayed on screen in place of Channel 1 of the 5D10. In this way, the 10 μV/div 5A22N may be used to provide a digitally stored display of a very low level differential signal. Or, a dual trace amplifier such as the 5A26, may be used in the left-hand plug-in compartment to permit the simultaneous color display of three signals, with color-coded cursor measurements available on each of the three.

In addition to its color operation with the 5D10 digital storage unit, the 5116 mainframe may also be used with any of the other 5100 Series plug-in units, with exactly the same functionality as the 5110 mainframe (see mainframe/compatibility chart on page 239).

## CHARACTERISTICS

The following characteristics are in addition to those listed previously.

### CRT AND DISPLAY FEATURES

**Standard CRT** — Internal 8 x 10 div (1.27 cm/div) parallax-free, illuminated graticule.

**Accelerating Potential** — 4.5 kV.

**Color Shutter** — With 5D10: Three-color display of blue-green, orange, and neutral. Without 5D10: Blue-green display.

**Beam Finder** — Positions beam on screen regardless of vertical and horizontal position control settings.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**5116** Oscilloscope **$2,460**

**Includes:** Power cord (161-0066-00); instruction manual (070-4544-00).

### OPTIONS

**Option 02** — Protective Panel Cover. The cover protects the front panel and knobs during transportation and storage. **+$40**

**Option 07** — Add Rear Panel Signals Out. **+$130**

### CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit** — Order 040-0583-03 **$155**

**Rackmount-to-Cabinet Conversion Kit** — Order 040-0584-04 **$180**

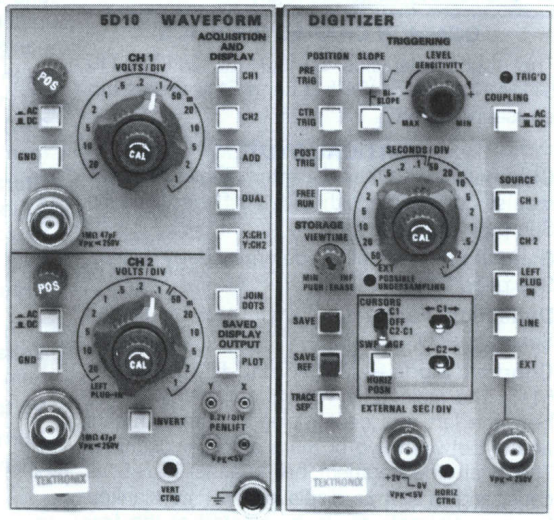
**Protective Panel Cover Kit** — Order 040-0620-00 **$38**

**Rear Panel Signal Outputs Conversion Kit (Option 07)** — Order 040-0915-02 **$230**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**For 5D10 Waveform Digitizer see next page.**
**For recommended cameras see page 406.**
**For a description and photos of color display technology see page 45.**




# 5D10

**Compatible with all 5000 Series Mainframes**

**Digital Storage**

**CRT Readout**

**Powerful Triggering Capability**

**1% Accuracy**

**Dual Channel**

**1 MHz Sample Frequency**

**Save Reference Waveforms**

**X-Y Recorder Output**

**Signal Conditioning Via Left Vertical Plug-In**

**Color Signal Source for 5116 Oscilloscope**

The 5D10 enhances all Tektronix 5000 Series mainframes by providing storage for transient events with frequency components up to 100 kHz for a single channel acquisition and up to 50 kHz for dual channel acquisition, all in a compact two-wide plug-in.

### Color/Waveform Digitizing System

Together, the 5D10 and the Tektronix 5116 Oscilloscope create a system of high resolution color*[1] and waveform digitizing for superior trace and readout clarity. Digital storage provides clear, crisp, bright displays which can be viewed indefinitely. And also the following additional features:

**Cursors** permit convenient single-point and point-to-point measurement of time, amplitude, and frequency for fast, accurate, and reliable answers.

*[1] *Three-color display requires a 5D10 with serial number B020000 or higher. A field installable kit is available to upgrade earlier 5D10's. Contact your local Tektronix representative for details.*

**CRT Readout** displays all pertinent instrument settings, cursors, and waveform levels. Lets you read out complete operational status at a glance.

**Pretrigger** allows viewing information prior to the trigger event so you can see all your data. Center and posttrigger selection is also provided.

**Free Run** optimizes the data presentation for low speed phenomena, much like a stripchart recorder.

**1% Accuracy** improves measurement quality in both vertical and horizontal modes.

**Dual Samplers** ensure time coincidence between the two input channels.

**Bi-Slope Triggering** assures triggering when the slope of a transient event is not known.

**1 MHz Sample Frequency** stores single-shot events to approximately 100 kHz in bandwidth with 8-bit vertical resolution.

**Storage View-Time** control from 1 second to infinity.

**Save Reference** permits comparisons of signals stored at different times.

**X-Y Displays** provide less than 1° phase shift up to 100 kHz of parametric related signals.

**X-Y Recorder Output** provides inexpensive, archivable hard copies complete with readout, graticule, and displayed waveforms in full color.

**Preconditioning** of up to two signals for Channel 2 by using the left vertical plug-in (when used in 5100 Series mainframes only).

For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10 μV/div (5A22N). The 5D10 can acquire a total of three signal channels when using the Channel 2 left plug-in acquisition feature.

## CHARACTERISTICS

### VERTICAL

**Vertical Modes** — CH 1, CH 2, Add, Dual, X-Y.

**Channel 2 Modes** — V/div, Left plug in.

**Deflection Factor** — 1 mV/div to 20 V/div in 14 calibrated steps (1-2-5 sequence).

**Accuracy** — Input to Readout Numbers: 5 mV/div to 1 V/div ±1%; 1 mV/div to 2 mV/div ±2%; 2 V/div to 20 V/div ±2%; Input to CRT graticule ±2%. From Left Vertical Plug-in: Add ±1% to above specifications. Add Mode: Add ±1% to above specifications.

**Input R and C** — 1 MΩ ±0.5% paralled by ≈47 pF.

**Maximum Input** — 250 V (dc + peak ac); 250 V p-p ac at 1 kHz or less.

**Bandwidth** — Single Channel: Suitable from dc to 100 kHz. Dual Channel: Suitable from dc to 50 kHz. Ac Coupling: 3 dB point—10 Hz or less (1 Hz with 10X probe).

**Common-Mode Rejection** — At least 50:1, dc to 100 kHz.

**Resolution** — Vertical: X-Y or Y-T; 0.04 div (8-bit digitzer). Horizontal: Y-T; 0.01 div (1024 memory locations shared among all traces displayed).

**Phase Shift** — ≤1.0° phase shift between CH 1 and CH 2, dc to 100 kHz.

**Display Output (to X-Y Recorder)** — Amplitude: 0.2 V/div ±2%. Speed: Compatible with X-Y recorders with 20 in/s slew rate, or faster. Pen Lift: Isolated switch contacts, SPST (floating); normally open or normally closed selected by internal jumper.

### TIME BASE

**Sweep Rates** — 0.1 ms to 50 s/div in 18 calibrated steps 1-2-5 sequence (to 10μs/div with 10X magnifier).

**Accuracy** — Within ±1% of readout numbers.

**External Input** — Allows external pulse generator to determine acquisition rate. Accepts TTL levels up to 1 MHz rate.

**Possible Under-Sampling Indicator** — Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossing of triggering signals.

### TRIGGERING

**Sources** — CH 1, CH 2, left plug-in (via mainframe), line, external.

**Coupling** — Dc, ac.

**Sensitivity** — External: 100 mV; dc to 50 kHz or pulsewidth >5 μs; 250 mV 50 kHz to 250 kHz or pulsewidth >1 μs. CH 1, CH 2, Left Plug-in: 0.4 div, dc to 50 kHz or pulsewidth >5 μs; 1.0 div, 50 kHz to 250 kHz or pulsewidth >1 μs.

**Bi-Slope Trigger** — Amplitude, frequency, and pulsewidth specifications apply to absolute value of signal (rectified).

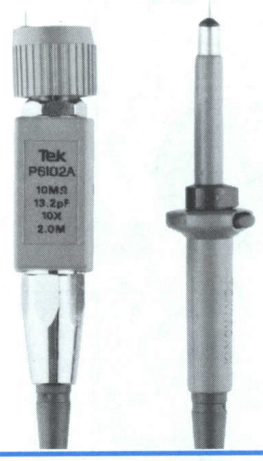
**External Trigger Input** — Input R and C: 1 MΩ ±2% paralleled by ≈47 pF. Maximum input 250 V (dc + peak ac). 250 V p-p ac at 1 kHz or less.

## ORDERING INFORMATION

**5D10 Waveform Digitizer** **$2,045**

**Includes:** Diagnostics manual (070-4323-00); operator manual (070-3696-01); service manual (070-3697-00).

# P6102A 10X Probe




**Dc to 60 MHz**

**Scale Factor Readout Coding**

**Fully Compatible with all 5100 Series**

The P6102A is a miniature 10X passive probe specially designed for use with all 5100 Series amplifier plug-ins, TM 500 Series SC 501, SC 502, and SC 503 plug-in oscilloscopes, and other scopes having nominal 47 pf inputs. Compensation range is 38 pf to 55 pf.

The P6102A automatically codes CRT readout-equipped scopes to show the correct scale factor and the knob-skirt readout on plug-ins with this feature. A ground reference button is included to provide easy location of ground position on the CRT and an easy means of identifying channels on multichannel displays.

The P6102A employs modular construction featuring just three snap-together modules. This means easy user repair and low maintenance costs.

## CHARACTERISTICS

**Length** — 2 m.

**Attenuation** — 10X ±3%.

**Input R and C** — 10 MΩ, 13.2 pf.

**Bandwidth** — Dc to >60 MHz.

**Risetime** — <5.9 ns.

**Aberrations** — ±3%, 5% p-p.

**Compensation Range** — 38 pf to 55 pf.

**Maximum Nondestructive Input Voltage** — 500 V (dc + peak ac).

### ENVIRONMENTAL

**Ambient Temperature** — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

**Humidity** — Five cycles (120 hours total) at 95% to 97%.

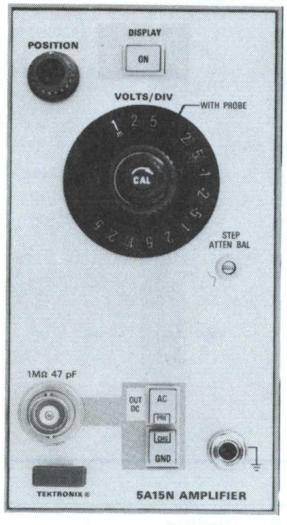
**Altitude** — Operating: To 4,600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

## ORDERING INFORMATION

**P6102A Miniature 10X Probe** **$75**

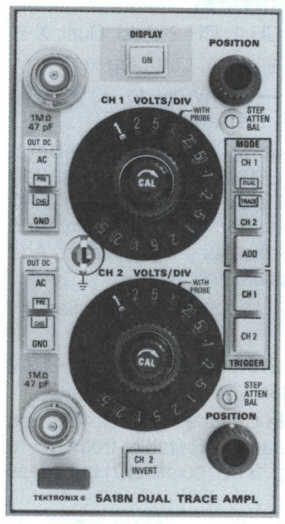
**Includes:** Retractable hook tip (013-0107-05); ground cover sleeve (166-0404-01); 130 mm ground lead (175-0124-01); 300 mm ground lead (175-0125-01); miniature alligator clip (344-0046-00); IC testing tip (015-0201-06); black marker band (334-2794-00); white marker band (334-2794-01); silver-grey marker band (334-2794-02); adjusting tool (003-1364-00); accessory pouch (016-0708-00); instruction manual (070-5824-00).

**5A15N**



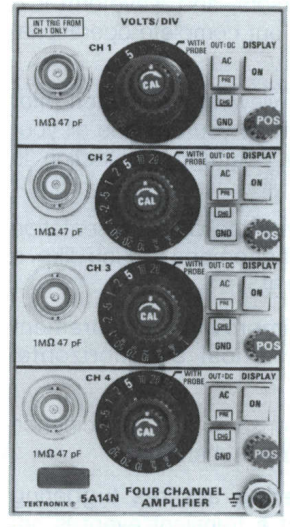

**Single Trace**

**5A18N**




**Dual Trace**

**5A14N**




**Four Trace**

## 5A15N Amplifier

**Dc to 2 MHz Bandwidth**

**1 mV/div to 5 V/div**

The 5A15N is the simplest of the 5A Series plug-in amplifiers to use. It provides a bandwidth of dc to 2 MHz in any 5000 Series mainframe at sensitivities to 1 mV/div. Two 5A15Ns may be used in a mainframe to provide dual-trace operation, or to provide 1 mV/div X-Y operation if one of the amplifiers is inserted in the right-hand compartment of mainframe.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input** — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

### ORDERING INFORMATION

**5A15N** Amplifier **$390**

**Includes:** Instruction manual (070-1136-00).

## 5A18N Amplifier

**Dc to 2 MHz Bandwidth**

**1 mV/div to 5 V/div**

The 5A18 is essentially a dual-trace 5A15N. Bandwidth is dc to 2 MHz in any 5000 Series mainframe at sensitivities to 1 mV/div. The Channel 2 signal may be inverted by means of a front panel switch to provide difference measurements of two signals in the ADD mode. The internal trigger signal is selectable from Channel 1 or Channel 2 by means of front-panel pushbuttons.

Dual trace X-Y operation may be obtained with a 5A18N in the right-hand compartment of any 5000 Series mainframe.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input** — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

**Chopping Rate** — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

### ORDERING INFORMATION

**5A18N** Amplifier **$815**

**Includes:** Instruction manual (070-1137-00).

## 5A14N Amplifier

**Dc to 1 MHz Bandwidth**

**1 mV/div to 5 V/div**

The 5A14N is a four-trace amplifier unit which provides 1 MHz bandwidth and sensitivity to 1 mV/div in any 5000 Series mainframe. Each channel may be displayed separately, or the channels may be alternated or chopped in any combination. The internal triggering signal is available from Channel 1 only. Two 5A14Ns may be combined to provide eight-trace operation in any 5000 Series mainframe.

### CHARACTERISTICS

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 1 MHz at all deflection factors.

**Deflection Factor** — Calibrated: 1 mV/div to 5 V/div in 12 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input** — Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V dc.

**Chopping Rate** — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

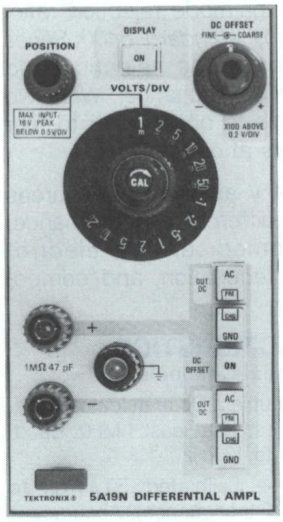
### ORDERING INFORMATION

**5A14N** Four Trace Amplifier **$1,620**

**Includes:** Instruction manual (070-1229-00).

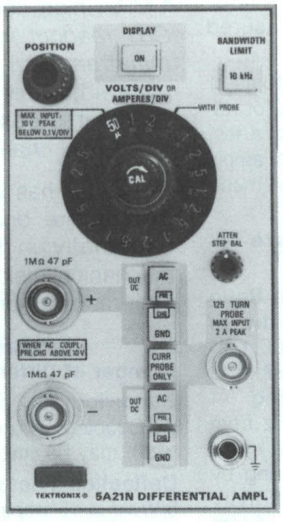
For recommended probes see pages 240 and 426.

5A19N




Differential Amplifier

5A21N




Differential Amplifier

# 5A19N

**Dc to 2 MHz Bandwidth**

**1 mV/div to 20 V/div**

**Dc Offset**

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000 Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

## CHARACTERISTICS

**Bandwidth —** Dc Coupled: Dc to at least 2 MHz at all deflection factors. Ac Coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor —** Calibrated: 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 50 V/div.

**Input R and C —** 1 MΩ within 0.3% paralleled by ≈47 pF.

**Signal and Offset Range**

| Deflection Factor Settings | 1 mV/div to 200 mV/div | 500 mV/div to 20 V/div |
|---|---|---|
| Common-Mode Signal Range | ±16 V | ±350 V |
| Maximum Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less) | ±350 V | |
| Maximum Ac Coupled Input (Ac Voltage) | ±350 V | |
| Dc Offset Range | +15 V to −15 V | +350 V to −350 V |

**Common-Mode Rejection Ratio —** Dc Coupled: 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

## ORDERING INFORMATION

**5A19N** Differential Amplifier **$470**

**Includes:** Instruction manual (070-1328-00).

For recommended probes see pages 240 and 426.

# 5A21N

**Dc to 1 MHz Bandwidth**

**10 kHz Bandwidth Limiter**

**50 μV/div to 5 V/div**

**100,000:1 CMRR**

**Voltage and Current Probe Inputs**

The 5A21N is a differential amplifier with a current probe input. In the voltage mode, it provides sensitivities of 50 μV/div to 5 V/div; with the optional P6021 Current Probe, it provides current sensitivities from 0.5 mA/div to 0.5 A/div.

## CHARACTERISTICS

**Bandwidth —** Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 2 Hz less at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor —** Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C —** Voltage Mode: 1 MΩ within 0.15% paralleled by ≈47 pF.

**Maximum Input Voltage**

| | Dc Coupled | Ac Coupled |
|---|---|---|
| 50 μV/div to 50 mV/div | 10 V (dc + peak ac) | 350 V dc (coupling cap precharged), 10 V peak ac |
| 10 mV/div to 5 V/div | 350 V (dc + peak ac) | |

**Input Gate Current —** 100 pA or less (equivalent to 100 μV or less, depending on external loading, at +25°C.

**Displayed Noise —** 30 μV or less, tangentially measured.

**Common-Mode Rejection Ratio —** Ac Coupled: 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc Coupled: at least 100,000:1 dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

### CURRENT PROBE INPUT (WITH P6021 CURRENT PROBE)

**Bandwidth —** 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor —** Calibrated: 0.5 mA/div to 0.5 A/div in 10 steps (1-2-5 sequence). Accuracy is within 3%. Uncalibrated: Variable is continuous between steps to at least 1.25 A/div.

**Maximum Input Current —** 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

**Displayed Noise —** 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.

## ORDERING INFORMATION

**5A21N** Differential Amplifier **$600**

**Includes:** Instruction manual (070-1139-01).

**Option 01 —** (Includes P6021, 5 ft current probe). **+$315**

**The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix sales engineer for details.**

# P6055

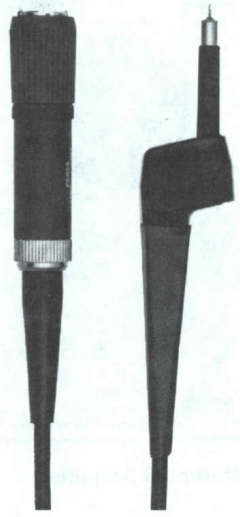
**20,000:1 CMRR 10X with Readout**

**High CMRR**

**Compact Size**

**Low Capacitance**

**Dc to 60 MHz**



The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows use with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provide the best possible system CMRR.

## CHARACTERISTICS

**CMRR —** 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

**Attenuation —** Adjustable to 10X.

**Input Resistance —** 1 MΩ ±0.5%.

**Input Capacitance —** ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

**Maximum Useful Bandwidth —** 60 MHz.

**Typical Probe Risetime —** 5.8 ns.

**Maximum Voltage —** 500 V (dc + peak ac) from dc to 12 MHz, p-p V derated to 100 V at 70 MHz.

## ORDERING INFORMATION

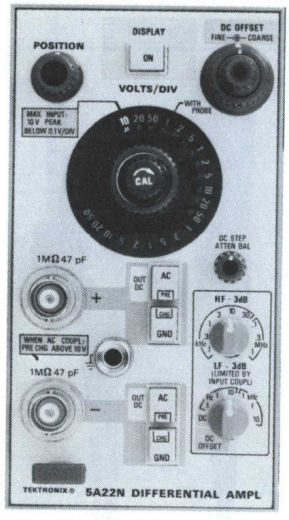
**P6055** 10X, Differential Probe
3.5 ft Cable. Order 010-6055-01 **$275**

**Includes:** Retractable hook tip (BB, 013-0107-05); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual (070-1115-00).

**Matched Pair of Two P6055 Probes.**
Order 015-0437-00 **$535**

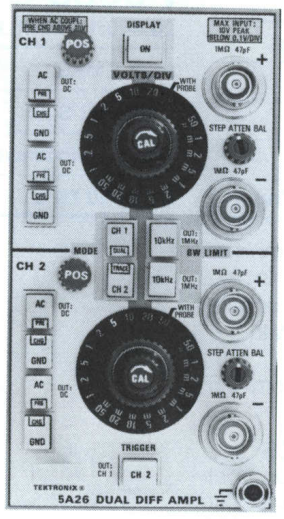
See page 446 for probe accessories.

**5A22N**




**Differential Amplifier**

**5A26**




**Dual Differential Amplifier**

# 5A22N

**Dc to 1 MHz Bandwidth**

**10 μV/div to 5 V/div**

**100,000:1 CMRR**

**Selectable Upper and Lower −3 dB Points**

**Dc Offset**

The 5A22N is the most versatile of the 5000 Series differential amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component, such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

## CHARACTERISTICS

**Bandwidth** — HF −3 dB Point: Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accuracy is within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF −3 dB Point: Selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accuracy is within 20% of selected frequency. Ac Coupled: 2 Hz or less.

**Deflection Factor** — Calibrated: 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 0.15% paralleled by ≈47 pF.

**Maximum Input Gate Current** — 200 pA or less.

**Displayed Noise** — 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

**Overdrive Recovery** — 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

**Drift with Temperature** — 100 μV/°C or less.

**Common-Mode Rejection Ratio** — Ac Coupled: 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc Coupled: At least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave.

**Signal and Offset Range**

| | | |
|---|---|---|
| Deflection Factor Settings | 10 μV to 50 mV/div | 0.1 V to 5 V/div |
| Common-Mode Signal Range | ±10 V | −350 V |
| Maximum Dc Coupled Input (dc + peak ac at 1 kHz or less) | ±12 V | ±350 V |
| Maximum Ac Coupled Input (dc voltage) | ±350 V Dc rejection, at least 4 x $10^5$:1 | |
| Dc Offset Range | +0.5 V to −0.5 V | +50 V to −50 V |

## ORDERING INFORMATION

**5A22N** Differential Amplifier **$1,190**

**Includes:** Instruction manual (070-1230-00).

**The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix sales engineer for details.**

# 5A26

**Dc to 1 MHz Bandwidth**

**50 μV/div Sensitivity at 1 MHz**

**100,000: 1 CMRR**

**2 Differential Amplifiers in One Plug-In**

**CRT Readout**

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000 Series laboratory oscilloscopes.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode rejection ratio, *CRT readout in any standard 5400 Series mainframe*, trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

## CHARACTERISTICS

**Number of Differential Channels** — Two.

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor** — Calibrated: 50 μV/div to 5 V/div in 16 steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated: Variable is continuous between steps to at least 12.5 V/div.

**CRT Readout** — CRT readout of deflection factors. Functional in CRT readout-equipped 5400 Series oscilloscopes, nonfunctional in 5100 Series oscilloscopes.

**Input R and C** — 1 MΩ within 0.15% paralleled by ≈47 pF.

**Maximum Input Voltage**

| | Dc Coupled | Ac Coupled |
|---|---|---|
| 50 μV/div to 50 mV/div | 10 V (dc + peak ac) | 10 V ac, 350 V (coupling cap precharged) |
| 100 mV/div to 5 V/div | 350 V (dc + peak ac) | 350 V (dc + peak ac) |

**Maximum Input Gate Current** — 100 pA or less (equivalent to 100 μV or less, depending on external loading) at +25°C.

**Displayed Noise** — 30 μV or less, tangentially measured.

**Common-Mode Rejection Ratio**

| | |
|---|---|
| Dc Coupled | |
| 50 μV/div to 50 mV/div | At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sinewave |
| 100 mV/div to 5 V/div | At least 300:1 from dc to 30 kHz with up to 100 V p-p sinewave |
| Ac Coupled | |
| 50 μV/div to 50 mV/div | At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz |

## ORDERING INFORMATION

**5A26** Dual Differential Amplifier **$1,305**

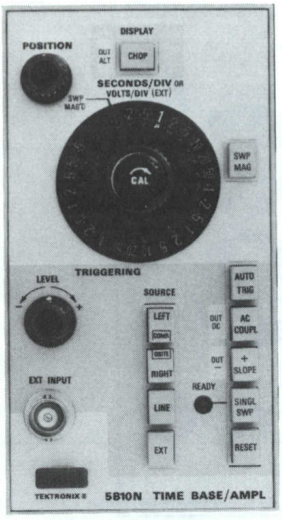
**Includes:** Instruction manual (070-1947-00).

### High CMRR Differential Probes

Matched pair of P6055 probes for maximum CMRR described on previous page.

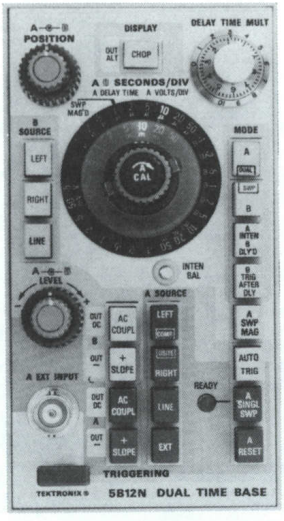
For recommended probes see pages 240 and 426.

**5B10N**




**Time Base/Amplifier**

**5B12N**




**Dual Sweep Time Base**

# 5B10N/5B12N

**100 ns/div to 5 s/div Calibrated Time Base**

**Single Sweep Operation**

**X10 Magnifier**

**Alternate and Chopped Displays**

**50 mV/div and 500 mV/div External Input**

**Dual and Delayed Sweep (5B12N)**

The 5B10N and the 5B12N time base units are designed for use with the Tektronix 5100 Series oscilloscope mainframes. They can also be used with the Tektronix 5400 Series mainframes, although they do not activate the scale factor readout in the 5400 Series. The 5B10N and the 5B12N both provide 1 μs/div to 5 s/div calibrated sweep rates; a 10X magnifier extends the fastest sweep rate to 100 ns/div.

The 5B12N is a dual time base unit which provides both delayed and dual sweeps. When the 5B12N is used in the delayed sweep mode, both the delaying and delayed sweeps may be displayed on screen, with all displayed signals being shown at both sweep rates. The delayed sweep may be made to run immediately after the expiration of a selected delay time, or may be made to wait for the next suitable triggering signal after the expiration of the selected delay time. Precise delay time is selected by means of a ten-turn potentiometer. Delayed sweep is used primarily for obtaining extremely high magnification of some portion of the displayed signal. It also provides a means of making more precise timing measurements on a displayed signal.

When the 5B12N is used in the dual-sweep mode, the two time bases are used independently of each other. The signal or signals from the vertical amplifier in the left hand compartment are displayed at the A time base rate, and the signal or signals from the vertical amplifier in the center compartment are displayed at the B time base rate. (When used with the dual-beam 5113 mainframe, the signals from both amplifiers are displayed at both sweep rates.)

Both the 5B10N and the 5B12N may be triggered from internal signals from either vertical amplifier, from an external triggering signal, or internally at the power line frequency. Auto triggering provides a bright base line in case of loss of triggering signal.

Both units have a single sweep mode which allows the user to set the time base to sweep once upon receipt of a triggering signal and then to remain locked out from producing further sweeps until manually reset. This mode is particularly useful in capturing single transients on one of the 5100 or 5400 storage mainframes.

An external signal input connector on both the 5B10N and the 5B12N allows their use as a conventional amplifier to provide X-Y operation of the oscilloscope without the need for switching plug-in units.

## CHARACTERISTICS

### MAIN SWEEP

The following specifications are the same for the 5B10N and the A sweep of the 5B12N. B sweep specifications are identical except where indicated.

**Sweep Rates** — Calibrated: 1 μs/div to 5 s/div in 21 steps (1-2-5 sequence). X10 Magnifier extends displayed sweep time/div to 100 ns. Uncalibrated: Continuously variable between steps and to 12.5 s/div. B Sweep: 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

**Sweep Accuracy** — Unmagnified: Within 3% from 1 μs/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Add 1% for magnified sweep operation. B Sweep: Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, 0.5 μs/div, 0.2 s/div, and 0.5 s/div.

### TRIGGERING

**Triggering Sensitivity**

| | Coupling | To 1 MHz | At 2 MHz |
|---|---|---|---|
| Dc | Internal | 0.4 div | 0.6 div |
| | External (A sweep only) | 200 mV | 200 mV |
| Ac | Requirements increase below 50 Hz | | |

**Auto Trig** — Same as above except signal rate requirements are 15 Hz and above.

**Single Sweep** — Same as for ac and dc coupled (A sweep only).

**External Trigger Input** — Maximum Input: 350 V (dc + peak ac). Input R and C: 1 MΩ within 2% paralleled by ≈70 pF. Trigger Level Voltage Range: +5 V to −5 V.

### EXTERNAL HORIZONTAL MODE

**Deflection Factor** — Calibrated: 50 mV/div and 500 mV/div. Accuracy is within 3%. X10 variable extends range to at least 5 V/div.

**Bandwidth** — Dc Coupled: Dc to at least 1 MHz. Ac Coupled: 50 Hz or less to at least 1 MHz.

**Input R and C** — 1 MΩ within 2% paralleled by ≈70 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

### DELAYING SWEEP (5B12N)

**Delay Time** — Accuracy: 1 μs/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%. Multiplier Range: 0.2 to 10.2 times the time/division setting. Multiplier Incremental Linearity: Within 0.2%.

**Differential Time Measurement Accuracy** — Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

**Jitter** — <0.05% of the time represented by one division of the delaying sweep selected.

## ORDERING INFORMATION

**5B10N** Time Base/Amplifier **$585**

**Includes:** Instruction manual (070-1140-00).

**5B12N** Dual Time Base **$1,230**

**Includes:** Instruction manual (070-1141-00).

# 5S14N

**Dc to 1 GHz Bandwidth**

**Dual Trace, 2 mV/div Sensitivity**

**Calibrated Delayed Sweep**

**Simplified Triggering**

**Operational Ease of Conventional Oscilloscope**

**Two-Dot Time Measurements**

## CHARACTERISTICS

### VERTICAL CHANNEL

**Modes —** CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 Invert); CH 1 Vertical (Y), CH 2 Horizontal (X).

**Input Impedance —** Nominally 50 Ω.

**Bandwidth —** Equivalent to dc to 1 GHz.

**Risetime —** 350 ps or less.

**Step Aberrations —** +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, both tested with a 284 Pulse Generator.

**Deflection Factor —** 2 mV/div to 0.5 V/div in eight steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

**Accuracy —** Within ±3%.

**Maximum Input Voltage —** ±5 V.

**Input Signal Range —** 2 V p-p maximum within a +2 V to −2 V window at any sensitivity.

**Dc Offset Range —** At least +2 V to −2 V.

**Displayed Noise —** 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

**Vertical Signal Output —** 0.2 V/div of vertical deflection; 10 kΩ source resistance.

**Channel Delay Difference —** Adjustable to zero, or for any time difference up to at least 1 ns.

### TIME BASE

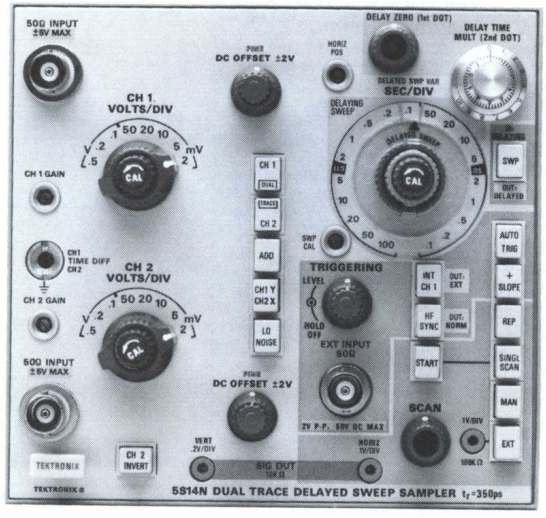
**Scan Modes —** Repetitive, single, manual, or external.

**Delaying Sweep —** May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the Time/Div.

**Delayed Sweep —** This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

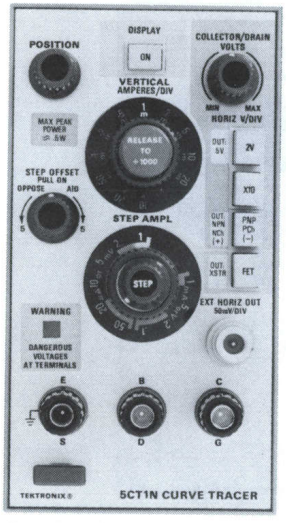
**Horizontal Signal Output —** 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

**5S14N**




**Sampler**

**5CT1N**




**Curve Tracer**

### DELAYING SWEEP

**Range —** 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

**Accuracy —** Within ±3%, excluding first 0.5 division of displayed sweep.

**Delayed Zero (1st Dot) —** Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the delaying sweep selected.

**Delay Time (2nd Dot) —** Adjustable to any position of the time interval represented by ten divisions of the delaying sweep selected.

**Delay Accuracy —** Within ±1% of ten divisions when measurement is made within the last 9.5 divisions.

### DELAYED SWEEP

**Range —** 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

**Accuracy —** Within ±3% excluding first 0.5 division of displayed sweep.

**Start Delay —** Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by ten divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

**Delay Jitter —** <0.05% of the time represented by one division of the delaying sweep selected.

### TRIGGERING AND SYNC

**Signal Sources —** Internal from CH 1 vertical input or external through front-panel connector.

**External Triggering —** Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

**Internal Triggering —** Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

**Triggered Mode —** Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

# 5CT1N Curve Tracer

**Test Semiconductor Devices to 0.5 W**

**10 nA/div to 20 mA/div Vertical Deflection Factors**

**0.5 V/div to 20 V/div Horizontal Deflection Factors**

For a complete description see page 402.

**5S14N continued**

**Autotrigger Mode —** For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the p-p voltage of the signal.

**Holdoff —** Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

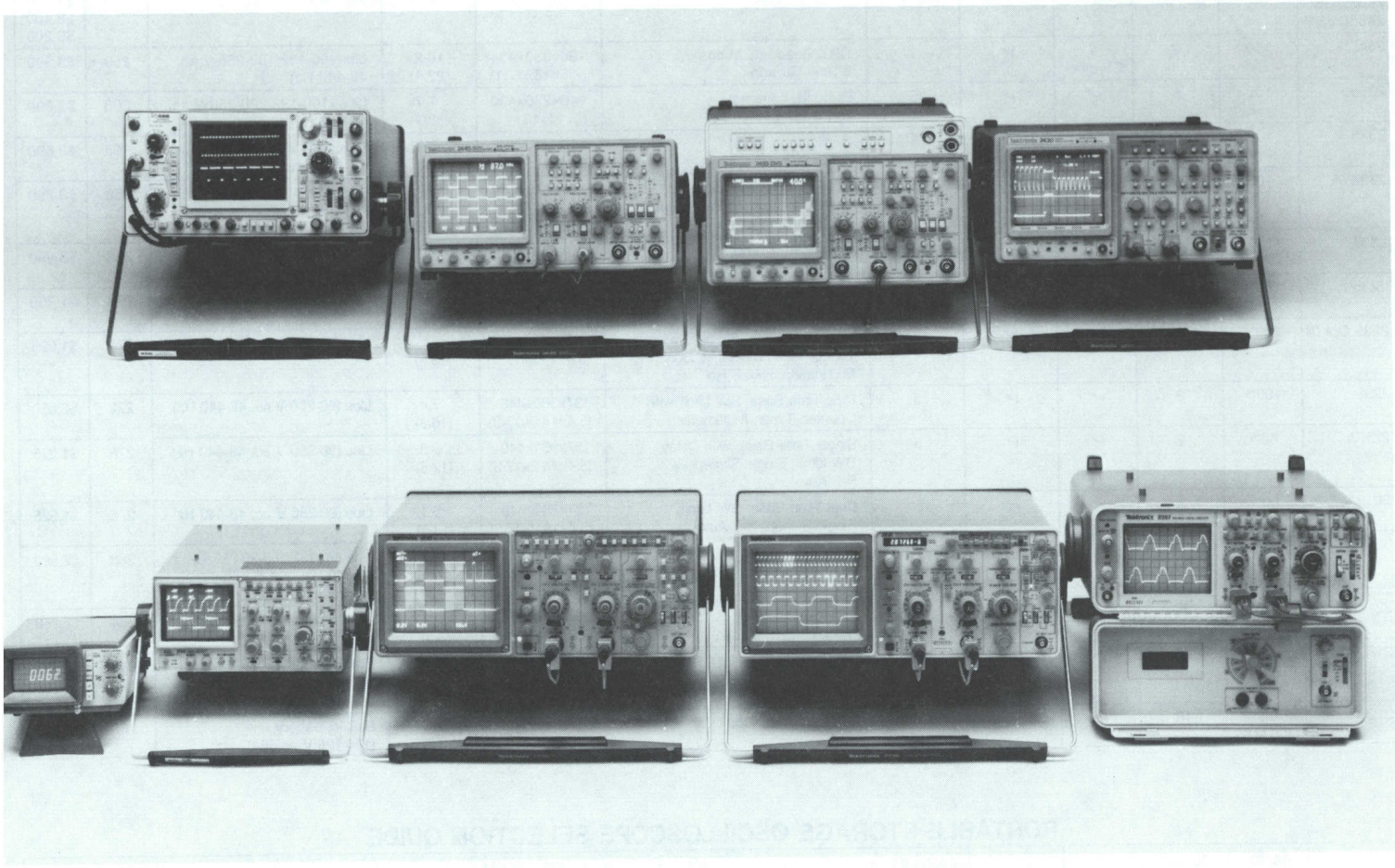
**HF SYNC Mode —** For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

## ORDERING INFORMATION

**5S14N** Dual-Trace Delayed Sweep Sampler for 5000 Series Oscilloscopes **$6,355**

**Includes:** Two X10 attenuators (011-0059-02); two 42 in 50 Ω coaxial cables (012-0057-01); instruction manual (070-1409-00).

# PORTABLE OSCILLOSCOPES



## CONTENTS


Portable Scopes Selection Guide ..... 254
Portable Scopes Application Notes ..... 255
Portable Scopes Accessories Chart ..... 255

**Portable Nonstorage Oscilloscopes**

485 350 MHz Dual Trace ..... 256
2465 300 MHz Four Channel ..... 259
2465 DVS Special Edition 300 MHz ..... 259
2465 DMS Special Edition 300 MHz ..... 259
2465 CTS Special Edition 300 MHz ..... 259
2445 150 MHz Four Channel ..... 259
2335 100 MHz Dual Trace ..... 268
2336 100 MHz Dual Trace w/Δ Time ..... 268
2336YA 100 MHz Dual Trace w/Δ Time, Elapsed Time Meter ..... 268
2337 100 MHz Dual Trace w/Δ Time & DMM 268
2236 100 MHz Dual Trace, Dual Time Base, w/Counter, Timer, Multimeter ..... 272
2235 100 MHz Dual Trace, Dual Time Base .. 274
2235 100 MHz Dual Trace, Option 01 Dual Time Base ..... 274
2213A 60 MHz Dual Trace, Single Time Base ..... 278
2215A 60 MHz Dual Trace, Dual Time Base ..... 278
305 Battery Powered 5 MHz/DMM ..... 283
221 5 MHz ..... 284
213 1 MHz/DMM ..... 285
212 500 kHz Dual Trace ..... 287

**Portable CRT Storage Oscilloscopes**

466 100 MHz Dual Trace, Dual Time Base ..... 288
314 10 MHz Dual Trace ..... 291
214 500 kHz Dual Trace ..... 292

**Portable Digital Storage Oscilloscopes**

2430 150 MHz Digital Storage ..... 307
2220 60 MHz Digital Storage ..... 310
2230 100 MHz Digital Storage ..... 310
336 50 MHz Digital Storage ..... 313

**Portable Power Accessories**

1105 Power Supply ..... 281
1106 Battery Pack ..... 281
1107 DC Inverter ..... 282
A6902B Isolator ..... 437
A6901 Ground Isolation Monitor ..... 438


**Tektronix offers the widest selection of portable scopes so you'll be able to choose the specific instrument that best suits your needs.**

25 portable scopes with many optional features are available with bandwidths from 500 kHz to 350 MHz.

All Portable Oscilloscopes listed in this section are available through the National Marketing Center by calling toll free 1-800-426-2200. In addition to being able to give you direct order entry, the NMC Sales Engineers are available to offer you immediate technical assistance about product specifications, capabilities, and applications. They can send you literature, discuss available accessories, tell you about payment terms and options, or help you contact your local sales and service office.

## PORTABLE REAL TIME OSCILLOSCOPE SELECTION GUIDE

| PRODUCT | BAND-WIDTH (MHz) | SENSI-TIVITY (mV/div) | DUAL TRACE | DELAYED SWEEP | FASTEST SWEEP (ns/div) | FEATURES | SIZE mm (in) HxWxD | WEIGHT kg (lb) | POWER REQUIREMENTS | PAGE | PRICES BEGIN AT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 485 | 350*1 | 5 | ✓ | ✓ | 1 | Widest BW in a portable instrument | 170x310x470 (7x12x19) | 9.5 (21) | Line (90-136/180-272 V ac, 48-440 Hz) | 256 | $9,100 |
| 2465*2<br>2465CTS*3<br>2465DMS*3<br>2465DVS*3 | 300 | 2 (100 MHz at 2 mV) | 4 Channel | ✓ | 500 ps | CRT Readout, ΔVolts ΔTime Cursors | 190x330x434 (7.5x13x17.1) | 10.2 (22.4) | Line (90-132/180-250 V ac, 48-440 Hz) | 259 | $5,350<br>$7,150<br>$8,400<br>$9,200 |
| 2445*2 | 150 | 2 | 4 Channel | ✓ | 1 | CRT Readout, ΔVolts ΔTime Cursors | 190x330x434 (7.5x13x17.1) | 10.2 (22.4) | Line (90-132/180-250 V ac, 48-440 Hz) | 259 | $3,590 |
| 2335 | 100 | 5 | ✓ | ✓ | 5 | Rugged, compact lightweight | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/200-250 V ac, 48-440 Hz) | 268 | $3,390 |
| 2336 | 100 | 5 | ✓ | ✓ | 5 | B Trigger, ΔTime | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/200-250 V ac, 48-440 Hz) | 268 | $3,690 |
| 2336YA | 100 | 5 | ✓ | ✓ | 5 | B Trigger, ΔTime, Elapsed Time Indicator, Extra probes and manual | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/200-250 V ac, 48-440 Hz) | 268 | $3,890 |
| 2337 | 100 | 5 | ✓ | ✓ | 5 | B Trigger, ΔTime, DMM | 140x270x430 (5x11x17) | 7.7 (17) | Line (100-132/100-250 V ac, 48-440 Hz) | 268 | $3,990 |
| 2235 | 100*4 | 2 | ✓ | ✓ | 5 | Dual Time Base, Single Sweep Trigger View, BW Limit | 137x360x440 (5.4x14.2x17.3) | 6.1 (13.5) | Line (90-250 V ac, 48-440 Hz) | 274 | $1,750 |
| 2235 Opt 01 | 100*4 | 2 | ✓ | ✓ | 5 | Dual Time Base, Single Sweep Trigger View, BW Limit, Scale Illumination, HF/LF Rej | 137x360x440 (5.4x14.2x17.3) | 6.1 (13.5) | Line (90-250 V ac, 48-440 Hz) | 274 | $1,995 |
| 2236 | 100*4 | 2 | ✓ | ✓ | 5 | Dual Time Base, BW Limit with Counter, Timer, Multimeter | 137x360x440 (5.4x14.2x17.3) | 7.4 (16.3) | Line (90-250 V ac, 48-440 Hz) | 272 | $2,650 |
| 2213A | 60*5 | 2 | ✓ | ✓ | 5 | Single Time Base, with Delay, BW Limit, Single Sweep P-P Auto | 137x360x440 (5.4x14.2x17.3) | 5.8 (12.8) | Line (90-250 V ac, 48-440 Hz) | 278 | $1,275 |
| 2215A | 60*5 | 2 | ✓ | ✓ | 5 | Dual Time Base, BW Limit, Single Sweep, P-P Auto | 137x360x440 (5.4x14.2x17.3) | 6.1 (13.5) | Line (90-250 V ac, 48-440 Hz) | 278 | $1,525 |
| 305 | 5 | 5 | ✓ | | 100 | Autoranging DMM battery power | 110x240x370 (4.4x9x15) | 4.8 (10.6) | Line (90-132/180-264 V ac, 48-440 Hz) built-in battery, or external dc | 283 | $2,590 |
| 221 | 5 | 5 | | | 100 | 5 MHz hand-held | 80x130x230 (3x5x9) | 1.6 (3.5) | Built-in battery,line (90- 250 V ac, 48-62 Hz) | 284 | $2,260 |
| 213 | 1 | 20 | | | 400 | DMM/scope at <4 lb (1.7 kg) | 70x130x230 (3x5x9) | 1.7 (3.7) | Built-in battery, line (90-136/ 180-250 V ac, 48-62 Hz), or external dc | 285 | $2,830 |
| 212 | 0.5 (500 kHz) | 10 | ✓ | | 1000 (1 μs/div) | Integral 1 MΩ probe | 80x130x240 (3x5x10) | 1.6 (3.5) | Built-in, battery, line (104-126 V ac 58-62 Hz) | 287 | $2,045 |

## PORTABLE STORAGE OSCILLOSCOPE SELECTION GUIDE

| PRODUCT | BAND-WIDTH (MHz) | SENSI-TIVITY (mV/div) | DUAL TRACE | DELAYED SWEEP | FASTEST SWEEP (ns/div) | FEATURES | SIZE mm (in) HxWxD | WEIGHT kg (lb) | POWER REQUIREMENTS | PAGE | PRICES BEGIN AT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2220 | 60 | 2 | ✓ | | 5 | Digital Storage 20 MS/s at 5 μs/div and faster | 137x237x440 (5.4x9.3x17.3) | 8.3 (18.0) | Line (90-250 V ac, 48-440 Hz) | 310 | $4,150 |
| 2230 | 100 | 2 | ✓ | ✓ | 5 | Digital Storage 20 MS/s at 5 μs/div and faster | 137x237x440 (5.4x9.3x17.3) | 8.3 (18.0) | Line (90-250 V ac, 48-440 Hz) | 310 | $5,150 |
| 2430 | 150 | 2 | ✓ | ✓ | 5 | Digital Storage 100 MS/s with 8 bit resolution and dual channel acquisition | 190x330x479 (7.5x13x18.8) | 11.1 (24.4) | Line (90-132 V ac/ 180-250 V ac, 48-440 Hz) | 307 | $8,900 |
| 466 | 100 | 5 | ✓ | ✓ | 5 | Fast transfer and Variable Persistence. 3,000 div/μs stored stored writing speed at reduced scan. | 160x330x550 (6x13x22) | 11.8 (26) | Line (99-132/198-264 V ac, 48-440 Hz) or battery pack | 288 | $7,560 |
| 336 | 50 | 5 | ✓ | ✓ | 100 | Digital Storage 1 Ms/s Microprocessor control and Menu driven*6 | 112x237x482 (4.4x9.3x14.6) | 5.1 (11.3) | Line (90-132/180-250 V ac, 48-440 Hz) | 313 | $4,960 |
| 314 | 10 | 1 | ✓ | | 100 | Bistable. Stored Viewing Time to 4 hr 400 div/ms Stored Writing Speed | 110x240x350 (4.4x9x14) | 4.7 (10.3) | Line (90-132/180/264 V ac, 48-440 Hz) or external dc | 291 | $4,315 |
| 214 | 0.5 (500 kHz) | 10 | ✓ | | 1000 (1 μs/div) | Bistable. 500 div/μs stored writing speed. Fully self-contained. | 80x130x240 (3x5x10) | 1.6 (3.5) | Built-in battery or line (104-126 V ac, 58-62 Hz) | 292 | $2,795 |

*1 *Bandwidth specifications for the 485 are dc to 350 MHz with 50 Ω inputs and dc to 250 MHz with 1 MΩ inputs.*
*2 *The 2445 and 2465 offer as options: 4 ½ digit DMM, 150 MHz Counter/Timer/Trigger, 17-Bit Word Recognizer, TV Trigger and GPIB Interface.*
*3 *Special Edition 2465.*
*4 *The 2235 and 2236 are specified 100 MHz for sensitivities from 5 mV to 5 V/div and 90 MHz in 2 mV.*
*5 *The 2213A and 2215A are specified 60 MHz for sensitivities from 5 mV to 5 V/div and 50 MHz in 2 mV.*
*6 *See specifications in digitizer section.*





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## PORTABLE SCOPE APPLICATION LITERATURE

Tektronix product literature is readily available from your local Tektronix sales office.

For data sheets and product brochures, just ask for literature on the specific instrument. Additional related publications also available are listed below.

| TITLE | FEATURING | PART NO |
|---|---|---|
| Portable Oscilloscope Selection Guide | A helpful aid for choosing the right portable scope for your needs | 38W-5158-2 |
| 2000 Series Warranty Brochure | Describes Tek's 3-year warranty on 2000 Series scopes and 5-year warranty plus service | 81W-5258 |
| 2400 Series Oscilloscopes | Brochure describes the 2445 and 2465 scopes | 38W-5139-2 |
| 2445/2465 | Instrument Interfacing Guide | 38W-5608 |
| New Portable Scopes | Article Reprint | 38W-5634 |
| 2445/2465 Reference Guide | Opt 10 GPIB<br>Opt 06 CTT/Opt 09 WR<br>Opt 01 DMM<br>Opt 05 TV | 38W-5722<br>38W-5723<br>38W-5724<br>38W-5725 |
| 2400 Special Edition Folder | | 38W-5736 |
| 2465 Feature/Benefit Guide | | 38W-5737 |
| 2400 Series Oscilloscopes | Brochure | 38W-5738 |
| 2465CTS Automatic & Semiautomatic Measurements | Application Note | 38W-5864 |
| 2400 Special Editions | Pocket Reference Guide | 38A-5838-1 |
| 2300 Brochure | Describes 2300 Series | 40W-5070-1 |
| 2235/36 Oscilloscopes | Brochure describes 2235/36 | 46W-5144-2 |
| Using the 2336 | Pocket Reference Guide | 46W-5732 |
| 2213A/15A/35 Brochure | Describes 2213A/15A/35 | 46W-4663-4 |
| 300 Series Portable Oscilloscopes | Brochure for the full line of SONY/TEKTRONIX mini-portable scopes | 40AX-3792-2 |
| 400 Series Portable CRT Storage Scopes | Describes of the 466, 464, and 434 portable storage scopes | 40W-3793-2 |
| Spotlight Hidden Pulses With High Speed Storage | Three-page application note that features the 466 | 40AX-3225 |
| The Digital Storage Oscilloscope | A primer that describes digital storage concepts and the 468 | 40W-4319-2 |
| Basic Oscilloscope Measurements: | Period and Frequency<br>Amplitude<br>Setup and Analysis<br>Dual-Trace and X-Y Phase<br>Rise Time | 41AX-3839-1<br>41AX-3840-1<br>41AX-3841-1<br>41AX-3928<br>41AX-3929 |

| TITLE | FEATURING | PART NO |
|---|---|---|
| 336 Brochure | Describes 336 | 53W-5426-1 |
| XYZs Of Using a Scope | A basic primer that features the 2200 Series | 46AX-4758-1 |
| XYZ's Instructor's Aid | | 46W-5169-2 |
| XYZ's Workbook | | 46W-5170-2 |
| Using Delayed Sweep In Measuring Digital Word Trains | Application Note | 41AX-3349 |
| VITS Analysis for TV Servicing | Application Note | 41AX-4047-1<br>46W-5207 |
| Basic Video System Measurements | Describes TV measurements using 2445/2465 Option 05 scopes | 38W-5511 |
| Electromagnetic Interference Article | Article Reprint | 40W-5582 |
| Pulse Parameters | Application Note | 46W-5205-1 |
| Frequency Measurements | Application Note | 46W-5206-1 |
| Pulse Ringing & Overshoot | Application Note | 46W-5209 |
| Swept Frequency Filter & Amplifier | Application Note | 46W-5210 |
| Power Supply Testing | Application Note | 46W-5211 |
| General Troubleshooting | Application Note | 46W-5212 |
| TDR Measurements with a Scope | Application Note | 46W-5215<br>46W-5216 |
| Pulse Rise Time | Application Note | 46W-5217-1 |
| Integrating a Scope | Article Reprint | 46W-5337 |
| Catch Glitches on Slow Sweep | Article Reprint | 41AX-4765 |
| Portables Storage | Selection Guide | 41W-5546 |
| 2445/65 TDR | Application Note | 38W-5221-1 |
| Quick & Easy Phase Measurement | Application Note | 38W-5223-1 |
| Chip CRT & Assembly | Article Reprint | 38W-5312 |
| Your Direct Line to the World's Best Instruments and Technical Expertise | Find out about the Tektronix National Marketing Center and Tek's service offices | 60A-4873-1 |

## PORTABLE SCOPE/ACCESSORIES COMPATIBILITY GUIDE

| | PROBES*5 | | | CAMERAS | | | CARTS | MISCELLANEOUS ACCESSORIES |
|---|---|---|---|---|---|---|---|---|
| | Passive | Active | Current | Single Shot or Low Rep Rate | Stored/Stable or Repetitive | Low Cost | | |
| 485 | P6101A P6063B<br>P6106A P6015<br>P6056 P6009<br>P6057 P6048<br>P6130 | P6201<br>P6202A<br>P6230 | A6302/AM 503<br>A6303/AM 503<br>P6022<br>P6021 | C-31B<br>016-0306-01<br>adaptor*1 | C-30B<br>016-0306-01<br>adaptor*1 | NA | K117<br>K212 | Folding Viewing Hood 016-0274-00 & 016-0082-00; 1105 Battery Power Supply Rain Cover 016-0554-00; Rack Adaptor 016-0558-00. |
| 466 | P6101A P6015<br>P6105A P6009<br>P6062B P6130 | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503<br>P6021 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1<br>C-4 122-0894-01 adaptor*1 | K117<br>K212 | Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; Protective Cover 016-0365-00; Mesh Filter 378-0726-01; 1105 Battery Power Supply; Rack Adaptor 016-0675-00. |
| 2430<br>2445<br>2465<br>2465 DVS<br>2465 CTS<br>2465 DMS | P6101A P6009<br>P6131 P6407<br>P6015<br>P6133 (2445) | P6201<br>P6202A<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503<br>P6021 | C-31B Opt 01<br>016-0269-03<br>adaptor*1 | C-30B Opt 01<br>016-0269-03<br>adaptor*1 | C-5C Opt 02 016-0359-01<br>adaptor*1<br>C-4 122-0894,01 adaptor*1 | K117<br>K212 | Folding Polarized Viewing Hood 016-0180-00; Collapsible Viewing Hood (Binocular) 016-0566-00; 1105 Battery Power Supply; Protective Cover 016-0720-00. |
| 2335<br>2336<br>2336YA<br>2337 | P6130 P6009<br>P6063B P6015<br>P6108A<br>P6101A (2336YA) | P6202A<br>P6201<br>P6230 | P6022<br>A6302/AM 503<br>A6303/AM 503<br>P6021 | NA | NA | C-5C Opt 04 016-0359-01<br>adaptor*1<br>(with flash) | K117<br>K212 | 2335 Rack Adaptor Kit 016-0468-00. |
| 2213A<br>2215A<br>2220<br>2230<br>2235<br>2235 Opt 01<br>2236 | P6101A P6009<br>P6130 P6015<br>P6062 P6230<br>P6122<br>P6121 (2236, 2230) | P6201<br>P6202A | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0269-03<br>adaptor*4 | C-31B Opt 01<br>016-0269-03<br>adaptor*4 | C-5C Opt 04 016-0359-01<br>adaptor*1*3 (with flash)<br>C-4 Option 02*4<br>C-7 Opt 02*4, Opt 03*4<br>C-5C Opt 02*4 | K117<br>K212 | Clear CRT Light Filter 337-2775-01; CRT TV Graticule Custom Mod; Accessories Pouch 016-0677-02; Front Cover 200-2520-00; RM Kit: 016-0466-00 for 2213A, 2215A and 2235; 016-0833-00 for 2235 Opt 01; 016-0015-00 for 2236; P6602 Temperature Probe 010-6602-00. |
| 314, 305<br>336 | P6101A<br>P6149A<br>P6148A (336) | | P6021 P6022<br>A6302/AM 503<br>A6303/AM 503 | C-31B Opt 01<br>016-0327-01<br>adaptor*2 | C-30B Opt 01<br>016-0327-01<br>adaptor*2 | | NA | Viewing Hood 016-0297-00; Mesh Filter 378-0063-00; 1105 Battery Power Supply; Rain Cover (314, 335) 016-0612-00. |

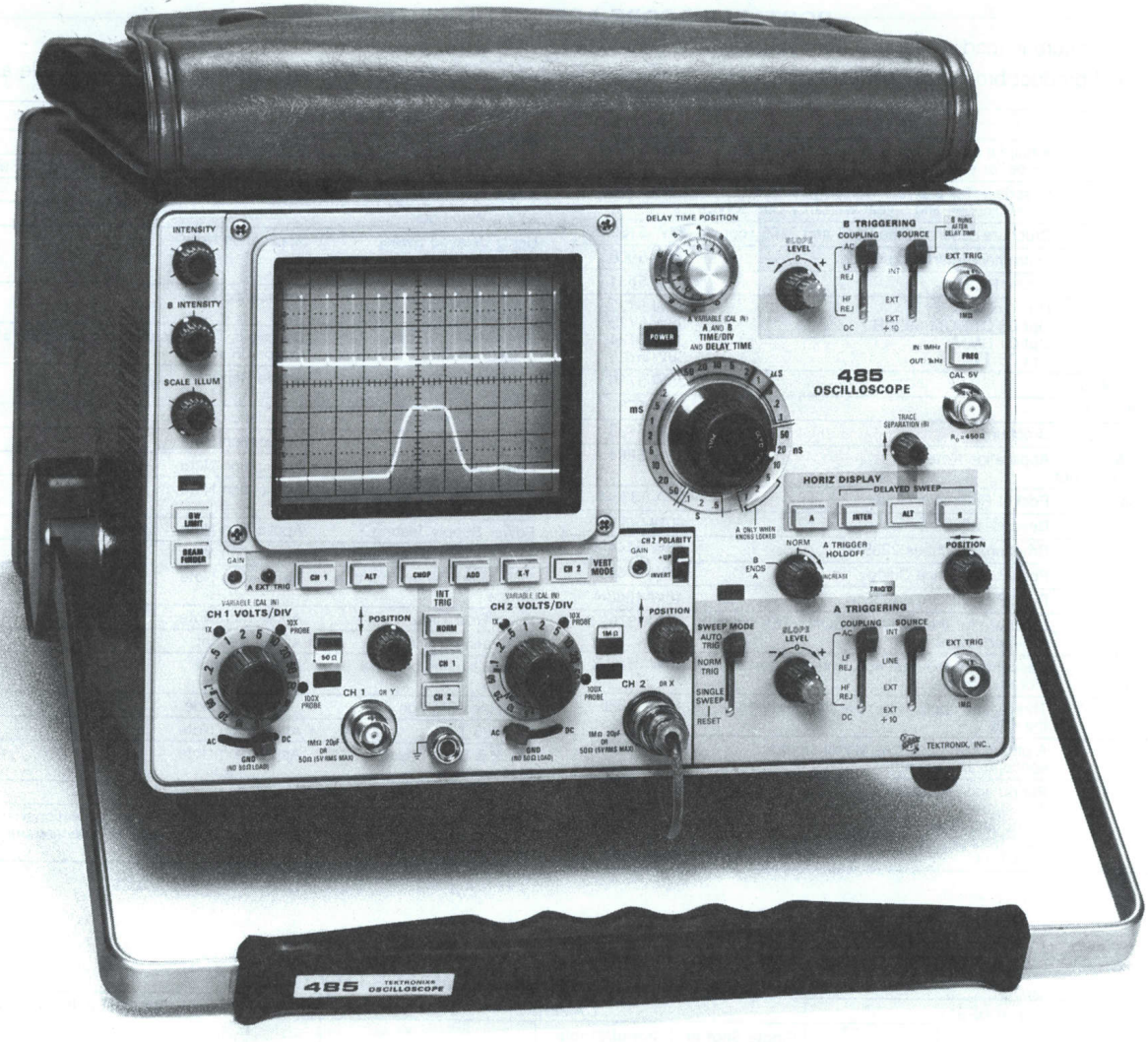
*1 *Mounting adaptor comes with camera/option listed, others are optional.*

*2 *Mounting adaptor must be ordered in addition to the camera/option listed.*

*3 *2235 Opt 01 Order C-5C Opt 02 or C7 Opt 03.*

*4 *Camera listings recommended for 2235 Opt 01 only.*

*5 *Highlighted probes are preferred for typical general purpose use and/or are shipped as included accessory to the instrument.*




## 485

- 350 MHz at 5 mV/div
- 1 ns/div Sweep Rate
- 2.0 div/ns Writing Speed
- 1 MΩ & 50 Ω Input Impedances
- Input Protection 50 Ω Internal
- Automatic Deflection Factor Readout
- Pushbutton Ext Trigger View
- Battery Operation (Optional)
- Weighs ≈9.5 kg (21 lb)

## TYPICAL APPLICATIONS

- * Digital Circuitry Design
- * Computer Memory Design (Disk or Tape Drive)
- * Laser Pulse Work
- * High Voltage Research Lab

At just 21 pounds, the 1 ns/div, dual-trace, 350 MHz 485 oscilloscope is highly compatible with today's increasing technology. Fast 2.0 div/ns writing speed makes it especially attractive for use in field research environments.

The 485 features a wide bandwidth at its full 5 mV/div vertical sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ). Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes.

Internal detection circuitry protects the 50 Ω input by automatically disconnecting when the signal exceeds approximately 50 V RMS.

You no longer have to mentally compensate for attenuating probes. Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance tells the correct on-screen V/div when the recommended 10X or 100X probes are used.

You always know exactly where you are in a pulse train when making a delayed sweep measurement. An alternate sweep mode allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, you can view the intensified zone and the delayed display simultaneously.

The external trigger signal can be easily viewed on the 485. A front-panel pushbutton automatically routes the external signal used to trigger time base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

On the 485, focus is always correct for single-shot photography. An autofocus circuit eliminates the need to readjust the focus each time the intensity is changed.

When commercial power is not available, use the 1105 Battery Power Supply. It weighs only 19.5 pounds, and lets you take the high-performance 485 virtually anywhere.

Often chosen as a general-purpose scope for computer and electronic servicing environments because of its fast writing speed and wide bandwidth, the 485 can also be found in specialized and unusual applications. For example, to maintain a ground-based laser/radar acquisition system, the 485's alternate sweep switching capability can be very useful.

## CHARACTERISTICS

### VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

**Bandwidth*1 and Risetime*2**

| | −15°C to +35°C | +35°C to +55°C |
|---|---|---|
| 50 Ω | Dc to 350 MHz, 1 ns | Dc to 300 MHz, 1.2 ns |
| 1 MΩ | Dc to 250 MHz, 1.41 ns | Dc to 200 MHz, 1.8 ns |

*1 *Measured at −3 dB. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.*

*2 *At all deflection factors from 50 Ω terminated source.*

**Lower −3 dB Point, Ac Coupling —** 1X Probe: 1 kHz or less for 50 Ω, and 10 Hz or less for 1 MΩ. 10X Probe: 100 Hz or less for 50 Ω, and 1 Hz or less for 1 MΩ.

**Deflection Factor —** Calibrated: 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: +2%. Uncalibrated: Continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

**Display Modes —** CH 1, CH 2 (normal and inverted), Alternate, Chopped (≈1 MHz rate), X-Y (CH 1-Y and CH 2-X), Add (CH 1 ± CH 2).

**Common-Mode Rejection Ratio —** At least 20 dB at 50 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor —** Probe tip deflection factors for 1X, 10X, and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

**Selectable Input Impedance —** 50 Ω and 1 MΩ impedances are available at a single BNC connector by pushbutton selection. 50 Ω ±0.5%; VSWR 1.15:1 or less from 20 mV/div to 5 V/div, 1.25:1 or less at 5 mV/div and 10 mV/div to 350 MHz.

**Input R and C —** 1 MΩ ±1% paralleled by ≈20 pF.

**50 Ω Protection —** Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

**Maximum Input Voltage**

| | | |
|---|---|---|
| 50 Ω | Protection disconnect occurs for voltages that exceed approximately:<br>5 V RMS continuous<br>0.1 W-second for instantaneous voltages of 5 V to 50 V | |
| 1 MΩ | Dc coupled | 250 V (dc + peak ac),<br>500 V p-p to 1 kHz |
| | Ac coupled | 500 V (dc + peak ac)<br>500 V p-p to 1 kHz |

**Selectable Input Coupling —** Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

**Delay Line —** Permits viewing leading edge of displayed waveform.

**Probe Power —** Connectors provide correct voltages for two optional P6201, P6202A or P6230 active probes.

### HORIZONTAL SYSTEM

**Time Base A and B —** Calibrated Sweep Range: 1 ns/div to 0.5 s/div (1-2-5 sequence).

**Variable Time Control —** Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

**Time Base A and B Accuracy*1**

| Sweep Rate | +15°C to +35°C | −15°C to +55°C |
|---|---|---|
| 1 ns/div to 20 ns/div | ±3% | ±5% |
| 50 ns/div to 0.1 s/div | ±2% | ±4% |
| 0.2 s/div and 0.5 s/div | ±3% | ±5% |

*1 *Center 8 division.*

**Horizontal Display Modes —** A, Intensified, Alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2, and 5 ns/div. B ends A for increased intensity in the delayed mode.

**Alternate Display Modes —** Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed sweep ≈4 div from the A sweep).

### CALIBRATED SWEEP DELAY

**Delay Time Range —** 0 to 10X delay time/div setting of 10 ns/div to 0.5 s/div.

**Differential Delay Time Measurement Accuracy**

| Delay Time Setting | +15°C to +35°C |
|---|---|
| 10 ns/div and 20 ns/div | ±(1% of measurement +0.2% of full scale)*1 |
| 50 ns/div to 1 ms/div | ±(0.5% of measurement +0.1% of full scale)*1 |
| 2 ms/div to 0.5 s/div | ±(1% of measurement +0.1% of full scale)*1 |

*1 *Full scale is 10 times the delay time/div setting.*

**Jitter —** 1 part or less in 20,000 of 10X the time/div setting.

### TRIGGERING A and B

**A Trigger Modes —** Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights Indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff —** Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for faster than 0.2 s/div.

**B Trigger Modes —** B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

**Time Base A and B Trigger Sensitivity and Coupling**

| Coupling | To 50 MHz | To 350 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1.5 div deflection |
| Dc External | 20 mV | 100 mV |
| Ac | Signals below 16 Hz are attenuated | |
| Ac LF Reject | Signals below 16 kHz are attenuated | |
| Ac HF Reject | Signals below 16 Hz and above 50 kHz are attenuated | |

**Jitter —** 0.1 ns or less at 350 MHz at 1 ns/div.

**A Trigger View —** A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷ 10 source).

**Level and Slope —** Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for external ÷ 10.

**A Sources —** Internal, line, external, external ÷ 10.

**B Sources —** B runs after delay time, internal, external, external ÷ 10.

**External Inputs —** R and C ≈1 MΩ paralleled by ≈20 pF. Maximum Input Voltage: 500 V (dc + peak ac), 500 V p-p to 1 kHz.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Vertical, CH 2 Horizontal) —** 5 mV/div to 5 V/div, accurate ±2%. Y-axis bandwidth identical to CH 1. X-axis bandwidth is dc to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

### CRT AND DISPLAY FEATURES

**CRT —** 8 x 10 division display (0.8 cm/div). Horizontal and vertical centerlines further marked in 0.2 division increments. Accelerating potential is 21 kV. GH (P31) Phosphor standard, BE (P11) optional.

**Photographic Writing Speed —** At least 1 div/ns with standard GH (P31) Phosphor and at least 2 div/ns with optional BE (P11) Phosphor using the Tektronix C-31B Camera and 3000 speed Type 107 film.

**Autofocus —** Automatically maintains beam focus for all intensity settings.

**Graticule —** Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder —** Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

**Z-Axis Input —** Risetime ≈15 ns. Input R ≈500 Ω. +0.2 V (dc to 20 MHz) decreases intensity. +2 V (dc to 2 MHz) blanks maximum intensity trace.



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## OTHER CHARACTERISTICS

**Two-Frequency, Fast-Rise Calibrator** — Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%, Amplitude is 5 V ±0.5% into 1 MΩ and 0.5 V ±1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA ±1%. Selectable repetition rates are 1 kHz and 1 MHz ±0.25%. Specifications apply over +15°C to +35°C range.

**A Sweep Output** — Open Circuit: ≈10 V positive-going sawtooth; into 50 Ω, ≈0.5 V.

**A and B Gate Outputs** — Open Circuit: ≈4 V positive-going rectangular pulse; into 50 Ω ≈0.5 V.

## POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 136 V ac and 180 V ac to 272 V ac. Recessed slide switch selects nominal operating line range.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 60 W at 115 V line.

## ENVIRONMENTAL

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −35°C to +75°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the 3 axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Operating and Nonoperating: 5 cycles (120 hrs) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, Class 4).

**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

## PHYSICAL CHARACTERISTICS

| | Cabinet | | Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 305 | 12.0 | 483 | 19.0 |
| Height | 168 | 6.6 | 177 | 7.0 |
| Depth | | | 457 | 18.0 |
| (handle extended) | 523 | 20.6 | | |
| (handle not extended | 470 | 18.5 | | |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net (with accessories) | 10.9 | 24.0 | | |
| Net (without accessories) | 9.5 | 21.0 | 11.9 | 26.2 |
| Shipping | 15.0 | 33.0 | 24.5 | 54.0 |

## ORDERING INFORMATION

**(PROBES NOT INCLUDED)**

**485** Oscilloscope **$9,100**

**Includes:** 18 inch 50 Ω BNC cable (012-0076-00); two BNC jack posts (012-0092-00); clear filter (386-0118-00); accessory pouch (016-0535-00 or 016-0537-00); four 3 amp fuses (159-0015-00); two 50 Ω terminators (011-0049-01); service manual (070-1193-00); operator manual (070-1194-00).

**R485** Rackmount Oscilloscope **$9,420**

**Includes:** Same as 485 plus mounting hardware and slide out assemblies.

## OPTIONS

**Option 04** — EMC Modification. **+$220**

**Option 78** — BE (P11) Phosphor. **+$200**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

**Option A2** — UK 240 V/13 A, 50 Hz.

**Option A3** — Australian 240 V/10 A, 50 Hz.

**Option A4** — North American 240 V/15 A, 60 Hz.

## OPTIONAL ACCESSORIES

### Passive Probes

| | Scope Input | Attenuation | Loading | Bandwidth*1 with 485 |
|---|---|---|---|---|
| P6056 6 ft | 50 Ω | 10X | 500 Ω 1 pF | 350 MHz |
| P6057 6 ft | 50 Ω | 100X | 5000 Ω 1 pF | 350 MHz |
| P6106A 2 m | 1 MΩ | 10X | 10 MΩ 13 pF | 250 MHz |
| P6130 1.5 m | 1 MΩ | 10X | 10 MΩ 12.7 pF | 250 MHz |
| P6063B 6 ft | 1 MΩ | Switchable 1X | 1 MΩ 12 pF | 6 MHz |
| | | 10X | 10 MΩ 14 pF | 200 MHz |

### Active Probes

| | | | | |
|---|---|---|---|---|
| P6230 1.5 m | 50 Ω/1 MΩ | 10X | 450 Ω 1.3 pF | 350 MHz |
| P6201 2 m | 50 Ω/1MΩ | 1X | 100 kΩ 3 pF | |
| | | 10X Head | 1 MΩ 1.5 pF | 330 MHz |
| | | 100X Head | 1 MΩ 1.5 pF | |
| P6202A 2 m | 50 Ω/1 MΩ | 10X | 10 MΩ 2 pF | 285 MHz |
| | | 100X Head | 10 MΩ 2 pF | |

### Current Probes

| | | | | |
|---|---|---|---|---|
| P6022 5 ft | 1 MΩ | Switchable*2 10 mA/div 100 mA/div | 0.03 Ω @ 1 MHz, 0.2 Ω @ 120 MHz | 935 Hz to 120 MHz |
| A6302/ AM 503 2 m | 50 Ω/1 MΩ | Selectable*2 1 mA/div to 5 A/div | 0.1 Ω @ 5 MHz, 0.5 Ω @ 50 MHz | Dc to 50 MHz |
| A6303/ AM 503 2 m | 50 Ω/1 MΩ | Selectable*2 10 mA/div to 5 A/div | 0.02 Ω @ 1 MHz, 0.15 Ω @ 15 MHz | Dc to 15 MHz |

*1 *Bandwidths measured at upper −3 dB for given cable lengths.*

*2 *Scope sensitivity set at 10 mV/div.*

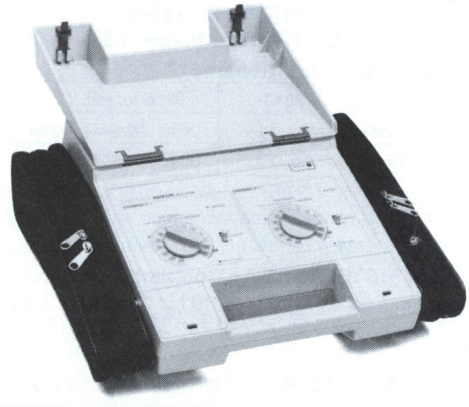
**Carrying Strap** — Order 346-0199-00 **$17**

**Current Loop Adaptor** — The adaptor provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is ≈25 ns. Order 012-0341-00 **$60**

**50 Ω 5X Pad** — Provides reverse termination for the calibrator. Order 011-0060-02 **$35**

**Folding Viewing Hoods** — Folds to 1.2 x 11.5 x 19.1 cm (7/16 x 7 ½ x 7 ½ in). Order 016-0274-00 **$15**

Folds to 1.4 x 17.2 x 34.9 cm (9/16 x 6¾ x 13¾ in). Order 016-0082-00 **$15**



**A6902B Isolator** — For floating measurements see page 437 for complete description. Order A6902B **$1,995**

**Battery Power Supply** — Order 1105 Battery Power Supply **$1,650**

**Rack Adaptor** — Order 016-0558-00 **$470**

### RECOMMENDED CAMERAS

For further information see camera section, page 412.

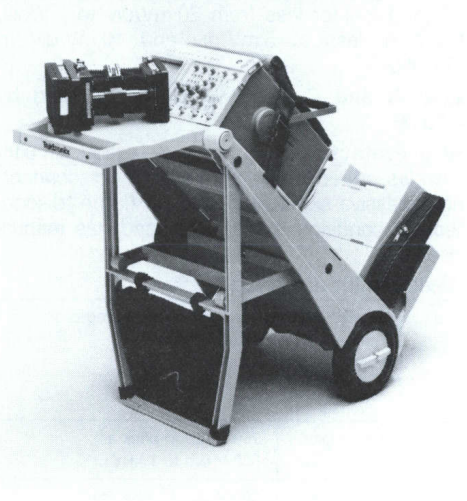
**C-30BP General Purpose Camera** — Includes 016-0306-01 mounting adaptor. Order C-30BP **$1,480**

**C-31BP High Speed Camera** — Includes 016-0306-01 mounting adaptor. Order C-31BP **$1,700**

### RECOMMENDED CARTS

**K212 Portable Instrument Cart** — For on-site mobility. See page 423. **$330**

**K117 Instrument Shuttle** — For site-to-site mobility. See page 423. **$265**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

GPIB

## Three *Special Editions* and Five Options

2465DVS

2465

## 2465/2445

- 300 MHz Bandwidth at Probe Tip (2465)
- 150 MHz Bandwidth at Probe Tip (2445)
- 500 ps/Div Sweep Rate (2465)
- 1 ns/Div Sweep Rate (2445)
- 2 mV/Div Vertical Sensitivity
- 500 MHz (2465) and 250 MHz (2445) Minimum Triggering Bandwidth
- Four Independent Channels
- Waveform Cursors
- Three-Year Warranty—Five Years Optional

GPIB IEEE-488

The 2465/2445 Option 10, 2465CTS, 2465DMS and 2465DVS comply with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

## 2465CTS Special Edition

**2465 Performance PLUS:**

- 10 ps Time Interval Resolution
- Crystal Controlled Time Base
- 0.001% Accuracy
- 150 MHz Counter/Timer
- Delay-By-Events Triggering
- Boolean Logic Triggering
- 17-Bit Word Recognizer Probe
- Fully Programmable

The 2465 Special Editions are also configured in an MP 2903 measurement package. See page 336.
Also available is EZ-TEK 2400 Software for test program generation.

## 2465DMS Special Edition

**2465CTS Performance PLUS:**

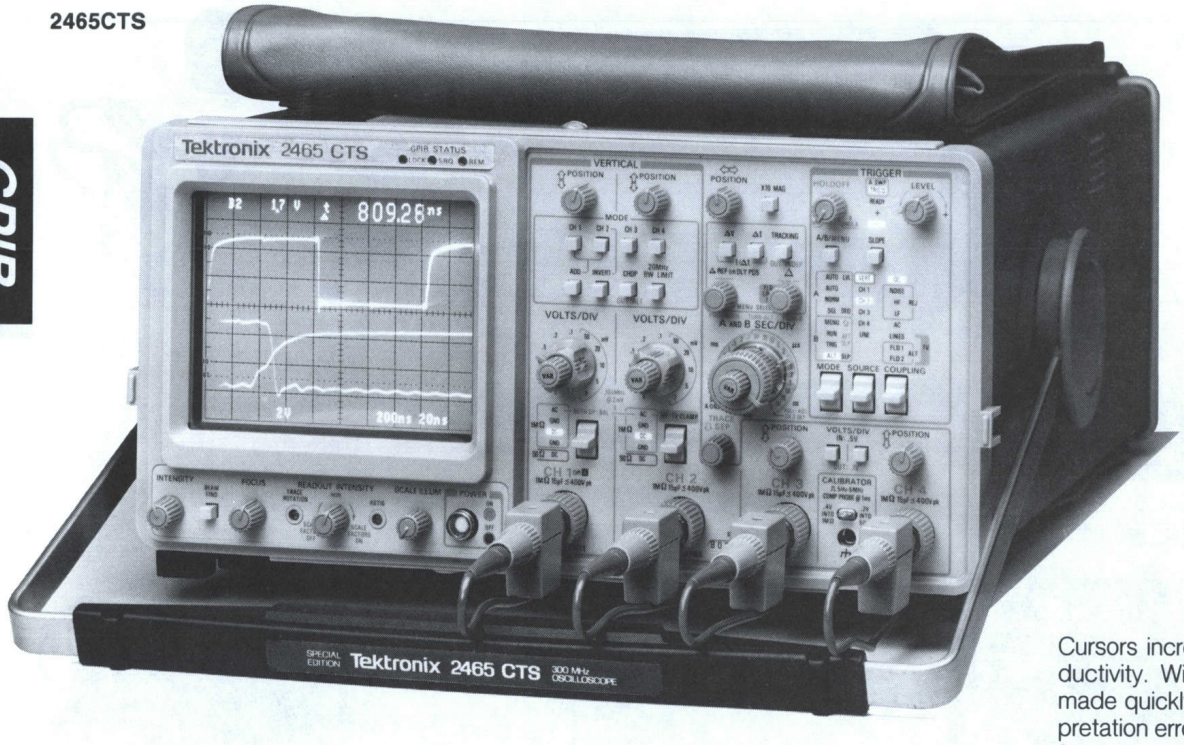
- 4 1/2 Digit Autoranging Digital Multimeter
- True RMS Ac Volts and Current
- Continuity Beeper
- DMM Calibration via Front Panel and GPIB
- 10 μV Resolution on Dc Volts
- Fully Programmable

## 2465DVS Special Edition

**2465DMS Performance PLUS:**

- TV Waveform Measurement System
- This System Includes all the 2465 Measurement Options for the Upmost in Versatility and Performance

2465CTS




The 300 MHz 2465 and 150 MHz 2445 represent the leading edge of technology, establishing higher standards in both value and performance for today's portable oscilloscopes. They enable faster and more precise measurements than ever before possible in a portable oscilloscope. For even more value, Tektronix is offering three *specially priced* products, the 2465DVS, 2465DMS, and 2465CTS. Each is configured with new options to greatly simplify complex measurements and substantially increase user productivity.

### Options

Five options can be ordered with the 2465 or 2445. Their descriptions follow the 2400 Series characteristics.

*GPIB IEEE Standard 488 Programmable for Semiautomatic Measurement Systems (Option 10)*

*150 MHz Counter/Timer/Trigger (CTT) with 17-Bit Word Recognizer (Option 09)*

*150 MHz Counter/Timer/Trigger (CTT) (Option 06)*

*TV Waveform Measurement System (Option 05)*

*4 ½ Digit Autoranging DMM (Option 01)*

### Multiple Option Allowance

When more than one option is ordered, a Multiple Option Allowance is applied to the purchase.

### Special Edition 2465DVS, 2465DMS, and 2465CTS

For maximum versatility and high-resolution video applications, choose the *2465DVS*. This is a *specially priced* and configured 2465 with five options: (1) a 4½ digit autoranging digital multimeter (Option 01); (2) a crystal-controlled time base, 150 MHz counter/timer/trigger and 17-bit word recognizer (Option 09); (3) an IEEE Standard 488 Interface Bus (Option 10) which provides complete talker/listener control, making the 2465DVS programmable; (4) the TV waveform measurement system (Option 05) and (5) two additional P6131 probes (Option 22).

For automatic test and measurement applications, the *2465DMS*, is a *specially priced* and configured 2465 with Options 01, 09, 10, 22.

The *2465CTS* is a *specially priced* and configured 2465 with Options 09, 10, and 22. It is ideal for automatically measuring frequency, period pulse width, and time between events. For moderate speed signals risetimes and falltimes can be automatically measured.

For more information about these instruments, refer to the characteristics and ordering information for the 2465 and the individual options.

### Precision Measurements

*Crystal Controlled Time Base (Option 09/06)*

*ΔVolts and ΔTime Cursors*

*Adjustable Channel 1—Channel 2 Delay Matching*

*Time-Interval Resolution to 20 ps (10 ps Option 09/06)*

*Calibrated Horizontal Variable*

The 2465/2445 Family oscilloscopes set new norms in measurement precision. With 1% horizontal system accuracy and 2% vertical deflection accuracy, they give you greater measurement confidence than ever before. On-screen vertical and horizontal cursors deliver immediate and accurate results of voltage, time, frequency, ratio, and phase measurements.

Cursors increase accuracy and operator productivity. With them, measurements can be made quickly, with almost no chance of interpretation errors and no CRT linearity error. The front-panel-controlled Channel 1—Channel 2 delay-matching adjustment compensates probe and vertical-channel delay differences.

### CRT Readouts

*Vertical and Horizontal Scale Factors*

*Trigger Level*

*Voltage, Time, Frequency, Phase, and Ratio Measurement Values*

*50 Ω Overload Condition*

*Mode Indicators*

*Probe Identification*

Readouts permit easy setup and interpretation of waveform displays. The horizontal time base always remains calibrated with three significant digits and a decimal point, even if variable settings are used.

### Versatile Triggering

*Hands-Off Auto Level Triggering*

*Predictable Triggering on Logic Thresholds and Intermittent Signals*

*Delay-By-Events and Boolean Triggering (Option 09/06)*

These oscilloscopes can trigger on any one of the four channels. Auto-level circuitry gives you convenient hands-off triggering, even with changing trigger-signal amplitudes. With the position-independent triggering, trigger level remains constant whenever you reposition the display. And the trigger-level readout enables you to preset the amplitude for predictable triggering on both logic thresholds and transient events.

Single-sequence triggering can capture a single event or multiple events by displaying a single sweep of each trace on the CRT. At the end of the sequence, scale factors and other readout data are briefly displayed and graticule illumination flashes on momentarily, allowing waveform photography.

### Measurement Convenience

*Four Independent Channels*

*B Sweep Displays A-Sweep Trigger Event*

*Selectable 50 Ω and 1 MΩ Input Impedances with 50 Ω Overload Protection*

Four channels produce clear and complete views to simplify complex measurements. With the B sweep you can display any portion of the A sweep, including the A-sweep trigger event. Sweep-delay range is adjustable down to zero delay. This combination allows easy timing measurements to be made on highly asymmetric or jittering waveforms. It provides accurate delayed- and Δ-time measurements—from the first pulse on the trace—and allows the operator to examine the A-trigger event in detail.

Input impedance is selectable between 1 MΩ and 50 Ω on Channels 1 and 2, eliminating the need for external 50-Ω terminators. Overload protection is also ensured. If excessive signal is applied while 50-Ω coupling is selected, coupling automatically switches to 1-MΩ coupling to prevent possible damage.

### Environmental

Exceptional electromagnetic compatibility qualities make the 2465/2445 Family oscilloscopes attractive for use in high-RF situations such as computer manufacturing, testing, and servicing. These instruments are also UL listed and CSA certified for safety. Their rugged design meets MIL-T-28800C environmental requirements for Type III, Class 3, Style C equipment.

### Reliability

Because of our confidence in their trouble-free performance, Tektronix offers a three year warranty. It covers all labor and parts, including CRT and excluding probes. You can also economically extend the warranty coverage up to five years by choosing from five practical service plans. These optional plans are designed to meet specific maintenance needs and are available in most countries.

## CHARACTERISTICS

Characteristics are common to the 2465/2445 Family except where indicated.

### VERTICAL SYSTEM

**Display Modes** — CH 1, CH 2, CH 3, CH 4, Add (CH 1 + CH 2); Invert (CH 2 only); Alternate and Chopped. Bandwidth Limit (20 MHz). If Var V/Div knob is rotated out of detent, efficient RATIO measurements can be performed with ΔV cursors.

#### CHANNEL 1 AND CHANNEL 2

**Deflection Factor** — 2 mV/div to 5 V/div in a 1-2-5 sequence.

**Accuracy** — ±2% for ≤5 div signals centered vertically for temperatures from +15°C to +35°C. Add ±1% of reading for temperatures from −15°C to +15°C and +35°C to +55°C. For 50 Ω Coupling, add ±1%. For CH 2 Invert, add ±1%.

**ΔV Accuracy** — ±(1.25% of reading + 0.03 div + signal aberrations) for temperatures from +15°C to +35°C. Add 1% of reading for temperatures from −15°C to +15°C and +35°C to +55°C. For 50 Ω Coupling, add ±1%. For CH 2 Invert, add ±1%. Measured with cursors, over the entire graticule area.

**ΔV Range** — ±8 times the Volts/Div switch setting.

**Variable Range** — Continuously variable between Volts/Div switch settings. Extends maximum deflection factor to at least 12.5 V/div.

**Frequency Response (3 dB Bandwidth and Risetime*1)** — With a 6 div signal, terminated in 50 Ω, with Var Volts/Div in calibrated detent.

| 2465 | Volts/Div Setting | With Standard Accessory Probe or Internal 50 Ω Termination |
|---|---|---|
| −15°C to +35°C | ≥5 mV | Dc to 300 MHz, 1.17 ns |
| +35°C to +55°C | ≥5 mV | Dc to 250 MHz, 1.4 ns |
| −15°C to +55°C | 2 mV | Dc to 100 MHz, 3.5 ns |
| **2445** | | |
| −15°C to +35°C | ≥5 mV | Dc to 150 MHz, 2.33 ns |
| +35°C to +55°C | ≥5 mV | Dc to 100 MHz, 3.5 ns |
| −15°C to +55°C | 2 mV | Dc to 80 MHz, 4.38 ns |

*1 *Risetime calculated from: Bandwidth x Risetime = 0.35*

**Ac Coupled Lower −3 dB Point** — With 1X Probe: 10 Hz or less. With 10X Probe: 1 Hz or less.

**Common-Mode Rejection Ratio** — At least 20:1 at 50 MHz for common-mode signals of 8 div or less, with Var Volts/Div control adjusted for best CMRR at 50 kHz at any Volts/Div setting ≥5 mV. At least 20:1 at 20 MHz at 2 mV/div.

**Channel Isolation** — 100:1 or greater attenuation of the deselected channel at 100 MHz; 50:1 or greater attenuation at 300 MHz (for 2465); 50:1 or greater attenuation at 150 MHz (for 2445). Measured with an eight-division input signal, deflection factors from 2 mV/div to 500 mV/div, and with equal Volts/Div switch settings on both channels.

**Displayed CH 2 Signal Delay with Respect to CH 1 Signal** — Adjustable through a range of at least ±500 ps.

**Input Z (1 MΩ)** — 1 MΩ ±0.5% shunted by 15 pF, ±2 pF. The maximum input voltage is 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less, for ac and dc coupling.

**Input Z (50 Ω)** — 50 Ω ±1%, with vswr of ≤1.3:1 from dc to 300 MHz (for 2465), or from dc to 150 MHz (for 2445). Maximum input voltage is 5 V RMS with 1-s averaging internal, ±50 V peak.

**Cascaded Operation** — CH 2 Signal Out is coupled into CH 1 input. Bandwidth is dc to 50 MHz or greater and the deflection factor is 400 μV/div ±10%.

#### CHANNEL 3 AND CHANNEL 4

**Deflection Factor** — 0.1 V/div and 0.5 V/div ±10%.

**Frequency Response (Bandwidth and Risetime)*1**

| 2465 | With Standard Accessory Probe (−3 dB) | With 50 Ω External Termination |
|---|---|---|
| −15°C to +35°C | Dc to 300 MHz 1.17 ns | Dc to 300 MHz, (−4.7 dB) 1.4 ns |
| +35°C to +55°C | Dc to 250 MHz 1.4 ns | Dc to 250 MHz, (−4.7 dB) 1.75 ns |
| **2445** | | |
| −15°C to +55°C | Dc to 150 MHz 2.33 ns | Dc to 150 MHz, (−3 dB) 2.33 ns |

*1 *With a 6 div signal, from a 50 Ω terminated source.*

**Input Z** — 1 MΩ ±1%, shunted by 15 pF ±3 pF.

**Maximum Input Voltage** — ±400 V (dc + peak ac): 800 V p-p ac at 10 kHz or less.

**Channel Isolation** — 50:1 or greater attenuation of the deselected channel at 100 MHz with an 8 div input signal.

#### ALL CHANNELS

**Low Frequency Linearity** — 0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

**Bandwidth Limiter** — Reduces upper 3 dB bandpass to a limit of 13 MHz to 24 MHz.

**Vertical Signal Delay** — At least 30 ns of the signal is displayed before the triggering event is displayed on the A sweep for settings ≥10 ns/div. At least 10 ns of delay is displayed at 5 ns/div for the 2465.

**Chopped Mode Switching Rate** — 2.5 MHz ±0.2% from 2 μs/div to 20 μs/div (1.25 MHz dual channel cycle rate). At All Other Sweep Speeds: 1 MHz ±0.2% (500 kHz dual channel cycle rate).

### HORIZONTAL SYSTEM

**Display Modes** — A, A Intensified, B Delayed, Alternate (A Intensified and B Delayed), B ends A for increased intensity in the delayed mode. For X-Y operation Channel 1 supplies the x-axis (horizontal) deflection.

**A Sweep Time Base Range**

2465: 0.5 s/div to 5 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 1 s/div to 10 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

**B Sweep Time Base Range**

2465: 50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 50 ms/div to 10 ns/div in a 1-2-5 sequence of 21 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

**Variable Time Control** — Continuously variable and calibrated between settings of the Sec/Div switch. Extends slowest A sweep speed to 1.5 s/div. Operates in conjunction with the A Sec/Div switch when A and B are locked together; operates in conjunction with the B Sec/Div switch when A and B are not locked together. When Var is out of detent position, the ΔT cursors give RATIO measurements, where five horizontal div are 100%. The variable control causes 1/ΔT cursors to give PHASE measurements where five horizontal div are 360°.

## CALIBRATED SWEEP DELAY

**Timing Accuracy** — Measured with Sec/Div switches set to 0.1 s/div or faster and temperature from +15°C to +35°C. (Refer to note below.)

| Parameter | Unmagnified | Magnified |
|---|---|---|
| A and B Sweep*1 | ±(0.7% of time interval +0.6% of full scale) | ±(1.2% of time interval +0.6% of full scale) |
| ΔTime (with Cursors)*2 | ±(0.5% of time +0.3% of full scale) | ±(1% of time inteval +0.3% of full scale) |
| ΔTime (with Delayed B Sweep)*3 | ±(0.3% of time interval +0.1% of full scale) | |
| Delay Time*4 | ±(0.3% of delay setting +0.6% of full scale), +0 ns, −25 ns | |

*1 *Time interval is measured on the center horizontal graticule line with Var Sec/Div control in detent (0.6% full scale is 0.06 div).*

*2 *Time interval is measured with cursors, anywhere on the graticule.*

*3 *Time interval is measured with Delayed B Sweep and with both delays set at 1% or more of full scale from minimum delay (no "?" displayed in readout).*

*4 *Delay time is from A Sweep trigger point to start of B Sweep.*

**NOTE:** With the A Sec/Div switch set to either 0.5 s or 0.2 s, add 0.5% of time interval to all accuracy specifications.

With the A Sec/Div switch set to 1 s (2445 only), add 2% of time interval to all accuracy specifications.

With the Var Sec/Div control out of detent, add 2% to both the A Sweep and the B Sweep accuracy specifications (except 1 s/div setting for 2445).

For temperature from −15°C to +15°C and from +35°C to +55°C, add 0.2% of time interval to all ΔTime and Delay Time specifications; add 0.5% of time interval to the A Sweep and the B Sweep accuracy specifications.

**ΔTime Readout Resolution**
2465: Greater of either 10 ps or 0.025% full scale.
2445: Greater of either 20 ps or 0.025% full scale.

**ΔTime Range** — ±10 times the A Sec/Div switch setting.

**Delay Pickoff Jitter** — Within 0.004% (one part or less in 25,000) of the maximum available delay, plus 100 ps.

**Delay Time Position Range** — 0 to 9.95 times the A Sec/Div switch setting. Main sweep triggering event is observable on delayed sweep with minimum delay setting.

## TRIGGERING

The minimum p-p signal amplitude for stable triggering is stated for CH 1 or CH 2 source. The signal amplitude for CH 3 or CH 4 source is one-half of CH 1 or CH 2 source specification. For multiple channel source (Alternate Vertical Mode) add 1 div to the single channel source specification.

**Dc Coupled** — 0.35 div from dc to 50 MHz, increasing to 1.5 div at 500 MHz (250 MHz for 2445).

**Noise Reject Coupled** — 1.2 div from dc to 50 MHz, increasing to 4.5 div at 500 MHz (250 MHz for 2445). An amplitude sensing mode, defined by increased trigger hysteresis. For signals within the vertical bandwidth, triggering *will not* occur (signal reject) with 0.4 div or less.

**Ac Coupled** — 0.35 div from 60 Hz to 50 MHz, increasing to 1.5 div at 500 MHz (250 MHz for 2445). Attenuates signals below 60 Hz.

**HF Reject Coupled** — 0.5 div from dc to 30 kHz.

**LF Reject Coupled** — 0.5 div from 80 kHz to 50 MHz, increasing to 1.5 div at 500 MHz (250 MHz for 2445).

**Jitter** — Less than 50 ps at 300 MHz with A and B Sec/Div set for 5 ns/div sweep and 10X Mag on (100 ps at 150 MHz and 10 ns/div for 2445).

**Trigger Level Control Range** — CH 1 or CH 2: ±18 times the Volt/Div setting. CH 3 or CH 4: ±9 times the Volts/Div setting.

**Trigger Level Control Readout Accuracy** — For triggering signals with transition times >20 ns.

**Channel 1 or Channel 2 Source (Dc Coupled):** ±[3% of Level setting +3% of p-p signal +0.2 div + 0.5 mV + (0.5 mV x probe attenuation factor)] for temperatures from +15°C to +35°C. Add 1.5 mV x probe attenuation factor for temperatures from −15°C to +15°C and +35°C to +55°C.

**Channel 1 and Channel 2 (50 Ω Coupled, Channel 2 Invert):** Add ±1% of setting to dc coupled specification at +15°C to +35°C.

**Channel 1 or Channel 2 Source (Noise Reject Coupled):** Add ±0.6 div to the dc coupled specification.

**Channel 3 or Channel 4 Source (Dc Coupled):** ±[3% of Level control setting +4% of p-p signal +0.1 div +(0.5 mV x probe attenuation factor)].

**Channel 3 or Channel 4 Source (Noise Reject Coupled):** Add ±0.3 div to the Dc Coupled specification.

Auto Level Mode Maximum Triggering-Signal Period — At least 20 ms with A Sec/Div settings <10 ms/div. At least four times the A Sec/Div setting with settings from 10 ms/div to 50 ms/div. At least 200 ms with A Sec/Div switch settings >50 ms/div.

**Auto Mode Maximum Triggering-Signal Period** — At least 80 ms with A Sec/Div settings <10 ms/div. At least 16 times the A Sec/Div settings from 10 ms/div to 50 ms/div. At least 800 ms with A Sec/Div setting >50 ms/div.

**Auto Level Mode Trigger-Acquisition Time** — From 8 to 100 times the specification for Auto Level Mode Maximum Triggering-Signal Period, depending on the triggering-signal period and waveform.

**Slope Selection** — Conforms to trigger-source waveform or ac power-source waveform.

**A Trigger Holdoff** — An adjustable control permits a stable presentation of repetitive complex waveforms. Extends A sweep holdoff to at least 10 times Sec/Div setting. At the fully clockwise setting, B sweep ends A sweep.

## X-Y OPERATION

**Three-Channel X-Y Display** — Channel 1 supplies the X-axis (horizontal) deflection signal. Any or all of the vertical channels (including Channel 1) can supply the Y-axis (vertical) deflection signal(s).

**X-Axis Deflection Factor Range, Variable Range, and Accuracy** — Same as Channel 1.

**X-Axis Bandwidth** — Dc to 3 MHz.

**Input Z** — Same as Channel 1.

**Phase Difference Between X and Y (Without Bandwidth Limit)** — ≤1° from dc to 1 MHz. ≤3° from 1 MHz to 2 MHz.

**X-Axis Low-Frequency Linearity** — 0.2 div or less compression or expansion of a two-div, center-screen signal when positioned within the graticule area.

## CURSOR AND FRONT PANEL DISPLAY

**ΔVolts Cursor Position Range** — At least the center 7.6 vertical divisions.

**ΔTime Cursor Position Range** — At least the center 9.6 horizontal divisions.

**Power Down Memory** — Front panel settings will be stored in nonvolatile memory provided no controls are moved for at least 10 s before power down.

## Z-AXIS INPUT

**Sensitivity** — Positive voltage decreases intensity. From dc to 2 MHz, +2 V blanks a maximum-intensity trace. From 2 MHz to 20 MHz, +2 V p-p modulates a normal-intensity trace.

**Input Resistance** — 9 kΩ ±10%.

**Maximum Input Voltage** — ±25 V peak; 25 V p-p ac at 10 kHz or less.

## SIGNAL OUTPUTS

**Calibrator** — Measured with the Sec/Div setting at 1 ms/div.

**Output Voltage and Current:** 0.4 V ±1% into a 1 MΩ load, 0.2 V ±1.5% into a 50 Ω load, or 8 mA ±1.5% into a short circuit.

**Repetition Period and Accuracy:** Two times the A Sec/Div setting for settings from 100 ns/div to 100 ms/div. Accuracy is ±0.1%, measured during sweep time or with Single Sequence A Trigger Mode selected.

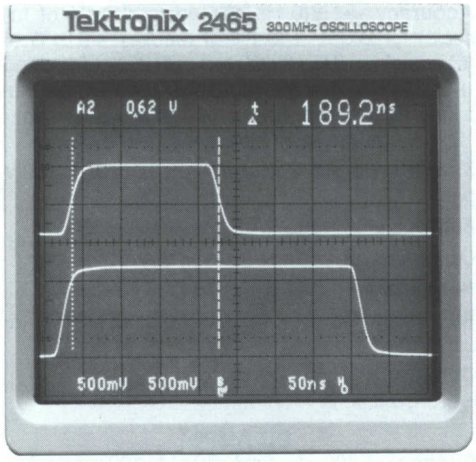
**Symmetry:** Duration of high-portion output cycle is 50% of the output period ±(the lesser of 500 ns or 25% of period).

**Pulse-Period or Pulse-Width Jitter:** 10 ns or less.

**CH 2 Signal Out:** Output Voltage: 20 mV/div ±10% into 1 MΩ, 10 mV/div ±10% into 50 Ω. Offset: ±10 mV into 50 Ω when dc balance has been performed within ±5°C of the operating temperature.

**A Gate Out and B Gate Out:** Output Voltage: 2.4 V to 5 V positive going pulse, starting at 0 V to 0.4 V. Output Drive: Will supply 400 μA during HI state; will sink 2 mA during LO state.

## CRT READOUT AND WAVEFORM INFORMATION




*Your eyes never have to leave the screen to obtain front panel settings and measurement results. In the CRT example above, the top area of the display provides trigger source, trigger voltage level, and Δtime results. The lower area displays the selected volts/div and seconds/div scale factors and that bandwidth limit and holdoff are activated.*

## CRT AND DISPLAY FEATURES

**Standard CRT** — 80 mm x 100 mm (8 cm x 10 cm).

**Standard Phosphor** — GH (P31) is standard.

**Nominal Accelerating Potential** — 16 kV.

## POWER REQUIREMENTS

**Line Voltage Ranges** — 115 V: 90 V to 132 V ac. 230 V: 180 V to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption** — Typical: 70 W (140 VA). Maximum: 120 W (180 VA).

## ENVIRONMENTAL AND SAFETY

The 2465/2445 Family oscilloscopes meet or exceed the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, tested for humidity 4.5.5.1.2.2, low temperature 4.5.5.1.3 and high temperature 4.5.5.1.4.

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held 10 minutes at each major resonance, or if none existed, held 10 minutes at 55 Hz (75 minutes total test time).

**Packaged Transportation Vibration** — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes.

**Humidity** — Operating and Nonoperating: Stored at 95% relative humidity for 5 cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.

**Shock** — Operating and Nonoperating: 50 g's,half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.

**Electromagnetic Compatibility** — Meets MIL-STD-461B for the following tests: RE02 Part 4 and 7; CE01 Part 2; CE03 Part 2; CS01 Part 2; CS02 Part 2; CS06 Part 2; RS01 Part 2; RS03 1 V/meter up to 1 GHz. Meets FCC Rules and Regulations, Part 15, Subpart J, Class A. Meets VDE 0871, Category B.

**Safety** — UL listed (UL 1244) and CSA certified (CSA 556B).

**Drip Proof** — With Cover On: Meets MIL-T-28800C Para. 4.5.5.5.3.

**Transit Drop** — Not in Shipping Package: 12 inch drop on each corner and each face (MIL-T-28800C, para 4.5.5.4.2).

**Packaged Transportation Drop** — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-2; 10 drops of 36 inches.

**Bench Handling** — With and Without Cabinet Installed: MIL-STD-810C, Method 516, Procedure V (MIL-T-28800C, para 4.5.5.4.3).

**Topple** — Operating and Cabinet Installed: Set on rear feet and allowed to topple over onto each of four adjacent faces.

## PHYSICAL CHARACTERISTICS

| For Standard Scope & Options | Cabinet | | Option 1R Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | | | 483 | 19.0 |
| (with handle) | 330 | 13.0 | | |
| Height | | | 178 | 7.0 |
| (with feet/pouch) | 190 | 7.5 | | |
| (without pouch) | 160 | 6.3 | | |
| (with Opt 01, with feet/pouch) | 230 | 9.0 | | |
| (with Opt 01, w/o pouch) | 199 | 7.8 | | |
| Depth | | | 419 | 16.5 |
| (with front panel cover) | 434 | 17.1 | | |
| (with handle extended) | 505 | 19.9 | | |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net (w/o accessories & pouch) | 9.3 | 20.5 | 13.3 | 29.3 |
| (with Opt 01 w/o accessories and pouch) | 9.9 | 22.0 | | |
| (with accessories & pouch) | 10.2 | 22.4 | 14.2 | 31.2 |
| (with Opt 01 with accessories and pouch) | 13.0 | 28.8 | | |
| Shipping | 12.8 | 28.2 | 19.1 | 42.0 |
| (with Opt 01) | 14.9 | 33.0 | | |

**Ordering Information** — See page 267.

# Option 10 GPIB Interface

GPIB IEEE-488

Bus Interface complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus Programmability**

**Remote Control of Front Panel Functions**

**Selectable at Front Panel:**
**Device Address, Talk/Listen Mode, Message Terminator**

**Front Panel Status Indicators:**
**REM (Remote), SRQ (Service Request), LOCK (Local Lockout)**

**Compatible with All Other 2465/2445 Options**

**User Generated SRQ:**
**To Signal Controller During Program Control**

**RQS Control:**
**Optional Enable or Disable of SRQ Reporting**

Option 10, which adds the ability to communicate over the General Purpose Interface Bus, transforms the 2465/2445 Family oscilloscopes into ideally suited components for use in a variety of semiautomatic test or measurement systems.

A host controller, such as the Tektronix 4041 can be easily programmed to assist the oscilloscope operator in performing a complete sequence of tests and measurements. Front panel settings can be remotely set or changed. It is possible not only to display scope parameters and settings on the CRT, but also to read them back over the GPIB to the controller. Similarly, the results of voltage, time, frequency, phase, and ratio measurements can be both displayed on the CRT and communicated back over the bus.

The ability to display prompting messages (by embedding them in control programs) reduces the chance of operator error at critical points in a test procedure.

Message structure for the 2465/2445 Family, like that for other Tektronix GPIB-controllable instruments, conforms with Tektronix *Standard Codes and Formats.* The abilty to select message termination characters facilitates use with most types of controllers.

## CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

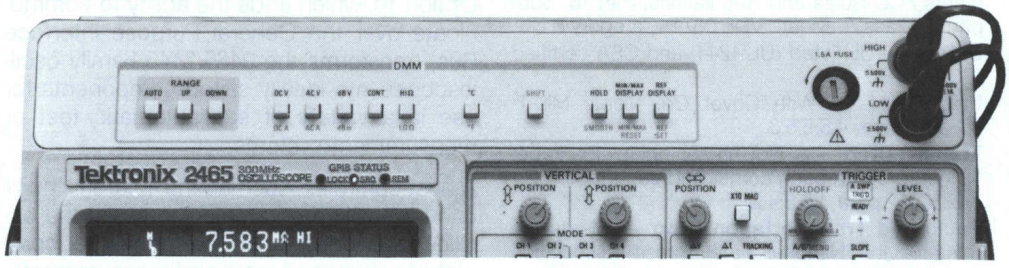
**Standard Interface Functions Implemented** — SH1, AH1, T6, L3, SR1, RL1, DC1, E1 DT0 C0, PP0.

**Vertical Position Accuracy** —

Channel 1 and Channel 2 (Noninverted): ±[0.3 div +3% of distance (in divisions) from center screen +0.5 mV divided by the Volt/Div setting]. Channel 2 Inverted: Add 0.2 div for −15°C to +55°C (excluding +15°C to +35°C) add 1.5 mV divided by the Volt/Div setting.

Channel 3 and Channel 4: ±[0.7 div +3% of distance (in div) from center screen].

**Ordering Information** — See page 267.




# Option 01 Digital Multimeter

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus a 4½ Digit Autoranging Digital Multimeter**

**True RMS Ac Volts from 20 Hz to 100 kHz**

**True RMS Ac Current from 20 Hz to 10 kHz**

**10 μV Resolution on Dc Volts**

**Continuity Beeper**

**UL Listed, CSA Certified**

**Temperature Probe −62°C to +230°C**

**Calibration via Front Panel without Removing Instrument Covers**

**Convenience Features Include: Set Reference, Hold, Smooth, Minimum/Maximum, dBV, and dBm**

Option 01 (DMM) complements the measurement demands placed on the 2400 Series oscilloscopes. This 4½ digit DMM offers features not normally found on other DMMs in its class, such as: (1) Direct readout of dBV and dBm; (2) Continuity with audible tone; (3) Display of minimum or maximum values of readings that occurred since the last reset or function change; (4) Averaging blocks of accumulated measurement values to create a smoothing or filtering effect when desired; (5) Rugged, designed to meet or exceed the requirements of MIL-T-28800C, Class 3 environment, thus ensuring reliable operation under the same temperature and humidity extremes as the 2400 Series oscilloscopes; (6) UL listed and CSA certified.

## CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

All accuracy specifications are stated with an operating temperature range of +18°C to +28°C and a relative humidity of 95% or less.

### DC VOLTAGE

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 500 V.

**Resolution** — 10 μV (4½ digits).

**Accuracy** — ±(0.03% of reading +0.01% of full scale). For 500 V range ±(0.03% of reading + 0.04% of full scale).

**Input Resistance** — >100 GΩ on the 0.2 V and 2 V ranges, 10 MΩ on the higher ranges. Resistance can be changed to 10 MΩ on all ranges.

**Normal-Mode Rejection Ratio** — ≥60 dB at 50 Hz and 60 Hz.

**Common-Mode Rejection Ratio** — 100 dB at dc, >80 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

**Maximum Input Voltage** — 500 V RMS, 700 V peak between inputs and ground.

**Response Time** — <2 s in Auto, <1 s in Manual range.

### AC RMS VOLTAGE

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 500 V.

**Resolution** — 10 μV (4½ digits).

**Accuracy** — ±(% of reading +% of full scale).

| Ranges | 200 mV to 200 V | 500 V |
|---|---|---|
| 20 Hz to 40 Hz | ±(0.7% +0.1%) | ±(0.7% +0.2%) |
| 40 Hz to 10 kHz | ±(0.3% +0.1%) | ±(0.3% +0.2%) |
| 10 kHz to 20 kHz | ±(0.7% +0.1%) | ±(0.7% +0.2%) |
| 20 kHz to 100 kHz | ±(5% +0.1%) | ±(5% +0.2%) |

**Crest Factor** — ≤4 at full scale.

**Common-Mode Rejection Ratio** — ≥60 dB at 50 Hz and 60 Hz with 1 kΩ imbalance.

**Response Time** — <3 s in Auto, <2 s in Manual range.

**Input Impedance** — 1 MΩ in parallel with <100 pF.

**Maximum Input Voltage** — 500 V RMS, 700 V peak between inputs and ground, not to exceed $10^7$ V-Hz product.

**dBV, dBm** — Calculated reading of ac voltage measurements. dBV is the display result equal to 20 Log ($V_{UNK}/V_{REF}$) where $V_{REF}$ = 1 V. dBm is referenced 1 mW into 600 Ω

### HI Ω RESISTANCE

**Ranges** — 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ 20 MΩ.

**Accuracy** — ±(0.1% of reading +0.01% of full scale) for 2 kΩ to 2 MΩ, ±(0.5% of reading +0.01% of full scale) for 20 MΩ. For Relative Humidity (RH) above 70%, add 2% of reading per 10% RH for the two highest resistance ranges.

**Maximum Input Voltage** — 500 V RMS 700 V peak.

**Full Scale Voltage** — 2 V.

**Open Circuit Voltage** — <6 V.

**Resolution** — 0.1 Ω (4½ digits).

**Response Time** — <2 s in Auto, <1 s in Manual range. <5 s in 20 MΩ range.

### LO Ω RESISTANCE

**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ.

**Accuracy** — ±(0.1% of reading +0.1% of full scale) for 200 Ω, ±(0.1% of reading +0.01% of full scale) for 2 kΩ to 200 kΩ, ±(0.25% of reading +0.01% of full scale) for 2 MΩ. For Relative Humidity (RH) above 70%, add 2% of Reading per 10% RH for the two highest resistance ranges.

**Maximum Input Voltage** — 500 V RMS, 700 V peak.

**Full Scale Voltage** — 0.2 V.

**Open Circuit Voltage** — <6 V.

**Resolution** — 0.01 Ω

**Response Time** — <2 s in Auto, <1 s in Manual range.

**Continuity** — An audible tone indicates <10 Ω. Reponse time is ≈0.1 s.

### DC AMPS

**Ranges** — 100 μA, 1 mA, 10 mA, 100 mA, 1 A.

**Accuracy** — ±(0.1% of reading +0.02% of full scale).

**Burden Voltage** — <150 mV up to 100 mA increasing to <500 mV at 1 A.

**Resolution** — 10 nA.

**Response Time** — <2 s in Auto, <1 s in Manual range.

### AC (RMS) AMPS

**Ranges** — 100 μA, 1 mA, 10 mA, 100 mA, 1 A.

**Accuracy** — ±(0.6% of reading +0.1% of full scale) from 20 Hz to 10 kHz.

**Burden Voltage** — <150 mV up to 100 mA increasing to <500 mV at 1 A.

**Resolution** — 10 nA.

**Response Time** — <3 s in Auto, <2 s in Manual range.

### TEMPERATURE

**Range** — −62°C to +230°C, ±(2% of reading +1.5°C). Readout may be in °C or °F with a resolution of 0.1°.

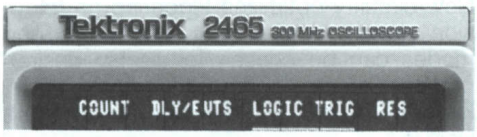
### OTHER CHARACTERISTICS

**Reading Rate** — Three readings/s nominal except 1.5 readings/s on 20 MΩ range.

**Temperature Coefficient** — ≤0.1 x the accuracy specification/°C from −15°C to +18°C and from +28°C to +55°C.

**GPIB Compatibility for Semiautomatic Measurement Systems** — When combined with Option 10, the DMM (Option 01) oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats*.

**Ordering Information** — See page 267.




# Option 09

**Counter/Timer/Trigger (CTT) with Word Recognizer (WR)**

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus Crystal-Controlled Time Base**

**0.001% Accuracy**

**Totalize up to 9,999,999 Events**

**Delay-By-Events Triggering up to a Total of 4,194,303 Events**

**Boolean Logic Triggering on Both Digital and Analog Signals**

**17-Bit Word Recognizer Probe**

Adding Option 09 to the 2400 Series oscilloscopes provides crystal-controlled time base accuracy for several time related measurements. Its use is fully integrated with the operation of the oscilloscope and with user on-screen menus. Four new 2400 Series capabilities are provided by this option: (1) Precision time-interval measuring; (2) Event and frequency counting; (3) Delay-by-events triggering; (4) Boolean logic triggering.

A 17-Bit word recognizer probe is available for a variety of applications, such as triggering on a word occurrence, counting words, or delaying the B sweep by a number of words.

## CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

**Sensitivity —** Signal input requirements for Frequency, Period, Totalize, Delay-by-Events and Logic Trigger.

| Input | Displayed Signal | Frequency Range |
|---|---|---|
| CH 1, CH 2 | 1.5 div | Dc (0.5 Hz for Frequency and Period) to 50 MHz |
| CH 3, CH 4 | 0.75 div | |
| CH 1, CH 2 | 4.0 div | 50 MHz to ⩾150 MHz |
| CH 3, CH 4 | 2.0 div | |

**Source —** A trigger or word recognizer for Frequency, Period, and Totalize.

### FREQUENCY

**Range —** Autoranging over input frequency from 0.5 Hz to 150 MHz.

**Resolution —** $\pm\left[\text{LSD} + 1.4 \times \frac{\text{TJE}}{\text{N}} \times (\text{F})^2\right]$

Where: LSD = Least Significant Digit (0.1 ppm of full scale)
TJE = Trigger Jitter Error
N = Number of cycles of measured frequency during measurement interval (0.5 s or 1 period of the input signal, whichever is greater).

**Display —** Seven digits, updates twice per second or every two periods, whichever is slower.

**Accuracy —** Resolution ±0.001% of reading over entire temperature range of −15°C to +55°C.

### PERIOD

**Range —** Autoranging over an input period from 6.666667 ns to 2 s.

**Resolution —** $\pm\left(\text{LSD} + 1.4 \times \frac{\text{TJE}}{\text{N}}\right)$

Where: LSD = Least Significant Digit (0.1 ppm of full scale)
TJE = Trigger Jitter Error
N = Number of cycles of measured frequency during measurement interval (0.5 s or 1 period of the input signal, whichever is greater).

**Display —** Seven digits, updates twice per second or every two periods, whichever is slower.

**Accuracy —** Resolution ±0.001% of reading over entire temperature range of −15°C to +55°C.

### ACCURACY AND RESOLUTION DEFINITIONS

**TJE (Trigger Jitter Error) =**

$$\sqrt{\frac{(\text{en1})^2 + (\text{en2})^2}{\text{Input Slew Rate}}}$$

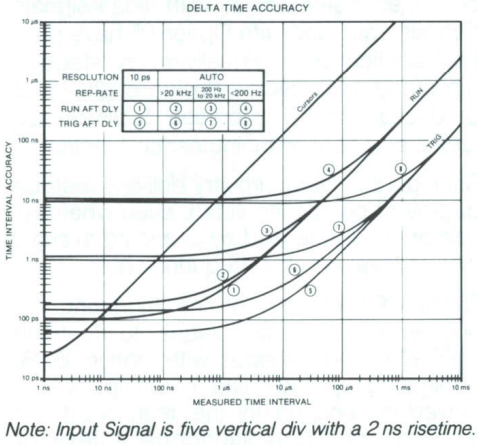
Where: en1 = RMS noise of vertical system in div on screen.
en2 = RMS noise voltage of input signal in divs.

| Volts/Div | Trigger Coupling | |
|---|---|---|
| | en1 Dc and Noise Rej | en2 HF Reject |
| 2 mV | 0.15 div | 0.05 div |
| 5 mV to 5 V | 0.1 div | 0.05 div |

### ΔTIME, 1/ΔTIME

**TRIG AFT DLY Accuracy —** ±(LSD +0.01 x B Time/div + 0.001% x A Sec/div +0.001% of reading +50 ps). Measured with signals (visually superimposed) having minimum Trigger Jitter Error and with channel-to-channel delay mismatch nulled out. (B Time/div includes 10X mag.)

**RUN AFT DLY Accuracy —** ±(LSD +0.0008 x A Sec/Div +0.01 x B Time/Div + 83 ps). (B Time/Div includes 10X mag.)




*Note: Input Signal is five vertical div with a 2 ns risetime.*
*Measured times are four horizontal div.*
*TJE is negligible for Slew Rates >0.1 div/ns.*
*ΔTime-TRIG AFT DLY assumes visual superposition.*

**Display Update Rate —** Auto resolution, twice per second or every four sweeps, whichever is slower. Depends on trigger and sweep rates with selectable resolution.

### PULSE WIDTH (ALT SLOPE)

When selected, displays the time interval defined by opposite slopes of a waveform using triggered delayed sweep.

**Accuracy —** Same as Δtime Triggered Mode.

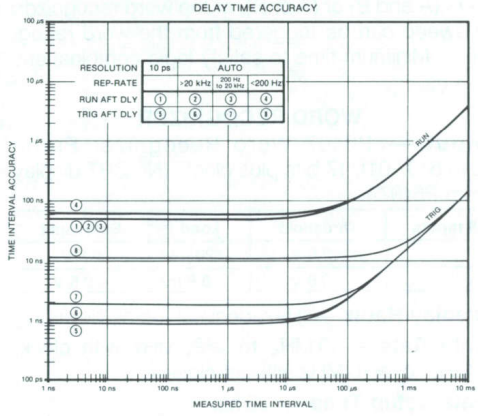
**Minimum Pulse Width —** ⩾1 ns.

**Display Update Rate —** Same as Δtime Mode.

### DELAY TIME

**TRIG AFT DLY Accuracy —** ±(LSD +0.001% of reading +0.5 ns +A trigger slew error +B trigger slew error). Add 0.5 ns for dual channel measurements.
Where: Trigger slew error equals trigger level control readout accuracy ÷ trigger signal slew rate at the trigger point.
When measured using word recognizer on the B Trigger: Add 100 ns using external clock; add 200 ns without external clock.

**RUN AFT DLY Accuracy —** ±(LSD +0.0012 x A Sec/Div +0.03 x B Time/div +50 ns). (B Time/div includes 10X mag.)
If measured using word recognizer on the B Trigger: Add 100 ns using external clock; add 200 ns without external clock.




*Note: Input Signal is five vertical div with a 2 ns risetime.*
*Measured times are four horizontal div.*
*TJE is negligible for Slew Rates >0.1 div/ns.*
*ΔTime-TRIG AFT DLY assumes visual superposition.*

**Display Update Rate —** Auto, twice per second or once for each sweep, whichever is slower. Depends on trigger and sweep rate for selectable resolution.

LSD Table

| A Sec/Div | Selected Resolution | LSD |
|---|---|---|
| 10 ns to 1 s | AUTO | See Auto Resolution on next page |
| 10 ns to 5 μs | 10 ps<br>100 ps<br>1 ns | 10 ps<br>100 ps<br>1 ns |
| 10 μs to 50 μs | 10 ps or 100 ps<br>1 ns | 100 ps<br>1 ns |
| 100 μs to 500 μs | 10 ps to 1 ns | 1 ns |
| 1 ms to 5 ms | 10 ps to 1 ns | 10 ns |
| 10 ms to 50 ms | 10 ps to 1 ns | 100 ns |
| 100 ms to 500 ms | 10 ps to 1 ns | 1 μs |
| 1 s | 10 ps to 1 ns | 10 μs |

Auto Resolution

| A Sec/Div | Trigger Repetition Rate | LSD |
|---|---|---|
| 10 ns to 2 μs | >20 kHz | 100 ps |
| 10 ns to 2 μs | 200 Hz to 20 kHz | 1 ns |
| 5 μs to 200 μs | >200 Hz | 1 ns |
| 10 ns to 200 μs | <200 Hz | 10 ns |
| 500 μs to 5 ms | Any | 10 ns |
| 10 ms to 50 ms | Any | 100 ns |
| 100 ms to 500 ms | Any | 1 μs |
| 1 s | Any | 10 μs |

*Note: 2445 A Sec/Div settings range from 20 ns to 1 s. 2465 A Sec/Div settings range from 10 ns to 500 ms.*

### TOTALIZE

**Maximum Count** — To 9,999,999 events.

### DELAY BY EVENTS

**A or B Sweep** — The A trigger or 17-bit word recognizer defines start events. The B trigger or 17-bit word recognizer defines delay events. Maximum delay count up to 4,194,303. Minimum time from start event to any delay event ≥4 ns. Minimum pulse width ≥3.3 ns. With A sweep in the delayed by events mode, the B sweep is delayable by time.

### LOGIC TRIGGER

**Combination Trigger** — A sweep can be triggered from logical combinations of A and B triggers (A and B) or (A or B), or the word recognizer. B sweep can be triggered from the word recognizer. Minimum time to satisfy logic combinations ≥4 ns.

### WORD RECOGNIZER

**Input** — P6407 Word Recognizer Probe (010-6407-01), 17 bits plus clock. (No CRT display from P6407.)

| All Inputs | Threshold | Load | Safe Limit |
|---|---|---|---|
| Hi | <2.0 V | <20 μA | 5.5 V |
| Lo | >0.6 V | >−0.6 mA | −0.5 V |

**Display Radix** — Hexadecimal, octal, binary.

**Data Rate** — 0 MHz to ≥20 MHz with clock, 0 MHz to ≥10 MHz without clock.

**Data Setup Time** — 25 ns.

**Data Hold Time** — 0 ns.

**GPIB Compatibility for Semiautomatic Measurement Systems** — When combined with Option 10 the CTT/WR (Option 09) Oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

**Ordering Information** — See page 267.

## Option 06

**Counter/Timer/Trigger (CTT)**

The Counter/Timer/Trigger is available without the word recognizer probe as Option 06. Specifications and included accessories (except WR probe) are the same as Option 09. The word recognizer cannot, however, be added to Option 06 after delivery (field retrofit kits are not available).

**Ordering Information** — See page 267.

*This sample waveform and CRT readout show a 2445's high-fidelity display of the Vertical Interval Reference Signal on Line 19, Field 1 with the television blanking-level clamp (TVC) engaged. The instrument used is also equipped with Option 10 (GPIB).*

## Option 05

**TV Waveform Measurement System**

**All of the High Performance Characteristics of Standard 2465/2445 Oscilloscopes Plus Television Waveform Analysis Capabilities**

**Selectable System-M and Nonsystem-M Protocols**

**Selectable Triggering on any Line with a Field, with Line-Number Readout**

**Compatible with Composite Video having 13.1 kHz to 77 kHz Line Rates**

**TV Blanking-Level Clamp (Back-Porch)**

**Optimized Vertical Response Comparable to High Performance TV Waveform Monitors**

Option 05 extends 2465/2445 oscilloscopes to versatile television waveform measurement systems. Enhanced features make these instruments especially useful for testing and troubleshooting any equipment that combines raster display with video signals. Scopes equipped with Option 05 have practical application in virtually every stage of the product life cycle—design engineering, production lines, calibration facilities, QA areas, and service/maintenance functions.

Back-porch clamp circuitry delivers a stable display of composite video, even when signals are characterized by changing average picture level and low frequency hum.

Direct CRT readout of the triggering line number is a feature unique to Tektronix 2465/2445 oscilloscopes with Option 05. By eliminating operator line counting, we removed the uncertainty that is inherent with less-advanced oscilloscope television options.

New circuitry optimizes triggering on television signals. Any of four trigger coupling modes can be chosen to display desired portions of the composite signal—Lines, Field 1, Field 2, Field 1 alternating with Field 2.

## CHARACTERISTICS

The set of characteristics is the same as specified for standard 2465/2445 oscilloscopes and includes the following additions:

### VERTICAL SYSTEM (CHANNEL 1 AND CHANNEL 2)

**Frequency Response** — For Volts/Div switch settings between 5 mV and 0.2 V with Var Volts/Div control in calibrated detent and using a 5-div, 50 kHz reference signal from a 50 Ω or 75 Ω system.

| Range | Frequency Reponse | |
|---|---|---|
| | With Full BW | With BW Limiting |
| 50 kHz to 5 MHz | ±1% | +1%, −4% |
| >5 MHz to 10 MHz | +1%, −2% | *1 |
| >10 MHz to 30 MHz | +2%, −3% | *1 |
| >30 MHz | *1 | *1 |

*[1] Same as 2445/2465.*

**Squarewave Flatness** — 1% p-p for both 60 Hz and 15 kHz squarewaves, from a 50 Ω or 75 Ω system using a 1.0 V input with a 50 mV/div setting and using a 0.1 V input at 20 mV/div setting. 1.5% p-p using a 0.1 V input with 5 mV/div and 10 mV/div settings. Setup with 1 MΩ dc input coupling, external 50 Ω termination, Var Volts/Div control in calibrated detent, and fast-rise input signal (risetime ≤1 ns). Exclude first 50 ns following step transition. For signals with risetimes ≤10 ns, add 2% p-p between 155 ns and 165 ns after step transition.

**Television Blanking-Level Clamp (Back-Porch) 60 Hz Rejection (Channel 2 Only)** — ≥18 dB at 60 Hz; with calibrated Volts/Div settings between 5 mV and 0.2 V, and a 6-div reference signal.

**Television Blanking-Level Clamp (Back-Porch) Reference** — Within 1.0 div of ground reference.

### TRIGGERING

**Sync Separation** — Stable sync separation from sync-positive or sync-negative composite video on systems with 525 to 1280 lines/frame, 50 Hz or 60 Hz field rate, interlaced or noninterlaced scan.

**Trigger Modes** — LINES, FLD 1, FLD 2, and ALT (FLD 1-FLD 2) coupling.

**Input Signal Amplitude for Stable Triggering Channel 1 and Channel 2** — 1.0 div for composite video and 0.3 div for composite sync signals (dc + peak video-signal amplitude must be within 18 div of input ground reference).

**Channel 3 and Channel 4** — 0.5 div for composite video and 0.25 div for composite sync signals (dc peak video-signal amplitude must be within 9 div of input ground reference).

**GPIB Compatibility for Semiautomatic Measurement Systems** — When combined with Option 10, the TV Waveform Measurement Systems (Option 05)/oscilloscope combination is fully programmable. Complies with Tektronix *Standard Codes and Formats.*

## ORDERING INFORMATION

**2465 300 MHz Oscilloscope** **$5,350**

**Includes:** Two P6131 10X 1.3 m probes with accessories (010-6131-01); 2 A, 250 V fuse (159-0021-00); zip lock accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-03); clear plastic CRT filter; snap accessory pouch (016-0692-00); front cover; power cord (161-0104-00); operator manual (070-3832-00); reference guide (070-4180-00).

**2445 150 MHz Oscilloscope** **$3,590**

**Includes:** Same as 2465, except two P6133 10X 2 m probes (P6133) and operator manual (070-3830-00).

**2465DVS 300 MHz Oscilloscope** **$9,200**

**Includes:** Same as 2465, plus DMM (Option 01), TV (Option 05), CCT/WR (Option 09), GPIB (Option 10), and two additional P6131 probes (Option 22). Provides most cost-effective combination of these options.

**2465DMS 300 MHz Oscilloscope** **$8,400**

**Includes:** Same as 2465, plus DMM (Option 01), CCT/WR (Option 09), GPIB (Option 10), and two additional P6131 probes (Option 22). Provides most cost-effective combination of these options.

**2465CTS 300 MHz Oscilloscope** **$7,150**

**Includes:** Same as 2465, plus CCT/WR (Option 09), GPIB (Option 10), and two additional P6131 probes (Option 22). Provides most cost-effective combination of these options.

### INSTRUMENT OPTIONS

**Option 01*3** — Digital Multimeter. **+$1,500**

**Includes:** Same as 2465 or 2445 instruments, plus probe set (012-0941-00); temperature probe (010-6602-00); probe set accessories (020-0087-00); DMM operator manual (070-4183-00); reference guide (070-5365-00).

**Option 05** — TV Waveform Measurement System. **+$1,050**

**Includes:** Same as 2465 or 2445 instruments plus CCIR graticule CRT filter (378-0199-01); NTSC graticule CRT filter (378-0199-02); polarized collapsible viewing hood (016-0180-00); operator manual (070-4629-00); reference guide (070-5382-00).

**Option 06** — Counter/Timer Trigger **+$1,000**

**Includes:** Same as 2465 or 2445 instruments, plus 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00); operator manual (070-4631-00); reference card (070-5382-00).

**Option 09*1*2** — CTT/Word Recognizer **+$1,400**

**Includes:** Same as 2465 or 2445 instruments, plus a word recognizer probe (010-6407-01); 20 grabber tips (206-0222-00); two 10 inch 10 wide comb (012-0747-00); operator manual (070-4631-00); reference card (070-5366-00).

**Option 10** — GPIB Interface **+$900**

**Includes:** Same as 2465 or 2445 instruments, plus operator manual (070-4633-00); reference guide (070-5364-00).

### MULTIPLE OPTION ALLOWANCE (MOA)

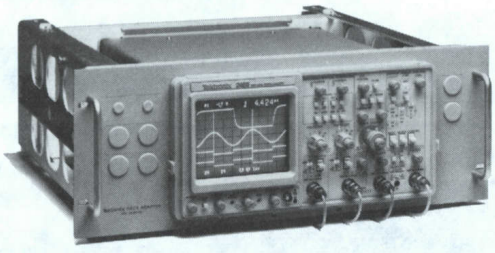
When a 2465 or 2445 is ordered with more than two of the above options, a special price allowance is applied. This allowance is not applicable to the 2465DVS, 2465DMS, or the 2465CTS specially priced edition.

**Option 2A** — MOA for combining two of the above options. **−$250**

**Option 3A** — MOA for combining three of the above options. **−$500**

**Option 4A** — MOA for combining four of the above options. **−$750**

### OTHER INSTRUMENT OPTIONS



*Rackmount 2465 Option 1R comes complete with slide-out chassis tracks.*

**Option 1R*3** — Configure Oscilloscope for Rackmount **+$320**

**Includes:** Same as 2465 or 2445 instrument (except pouch) plus rackmount hardware and slide-out assemblies.

**Option 11*1** — Rear Panel Probe Power. **+$165**

**Option 22** — Two additional P6131 Probes. **+$250**

**1 Option 11 may not be ordered with Option 09 or the 2445.*

**2 Option 09 includes Option 06.*

**3 Option 1R may not be ordered with Option 01. For rackmounting Option 01, 2465DVS, and 2465DMS contact your Tektronix sales office.*

*NOTE: Options 01, 05, 06, 09, and 10 are not retrofitable with field upgrade kits.*

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### *WARRANTY-PLUS* SERVICE PLANS— SEE PAGE 458

**M1** — (2465 and Special Editions) 2 Calibrations. **+$265**

**M1** — (2445) 2 Calibrations. **+$255**

**M2** — (2465 and Special Editions) 2 Years Service. **+$270**

**M2** — (2445) 2 Years Service. **+$215**

**M3** — (2465 and Special Editions) 2 Years Service and 4 Calibrations. **+$695**

**M3** — (2445) 2 Years Service and 4 Calibrations. **+$645**

**M4** — (2465 and Special Editions) 5 Calibrations. **+$670**

**M4** — (2445) 5 Calibrations. **+$660**

**M5** — (2465 and Special Editions) 9 Calibrations + 2 Years Service. **+$1,350**

**M5** — (2445) 9 Calibrations + 2 Years Service. **+$1,295**

## OPTIONAL ACCESSORIES

**Rackmounting Coversion Kit** — Not compatible with Option 01. Order 016-0691-01 **$350**

**Probe Power Extender Cable for Rackmount 2445/2465 Option 11** — Order 020-0104-00 **$410**

**Word Recognizer Extender Cable for Rackmount 2445/2465 Option 09 and 2465CTS** — Order 020-0103-00. **$32**

**GPIB Cable**— Double shield, low EMC.
(1m) Order 012-0991-01 **$135**
(2m) Order 012-0991-00 **$150**

**Viewing Hood** —
(Polarized Collapsible) Order 016-0180-00 **$40**
(Folding Light Shield) Order 016-0592-00 **$13**
(Folding Binocular) Order 016-0566-00 **$18.50**

**Protective Waterproof Blue Vinyl Cover** — Order 016-0720-00 **$22**

**Carrying Case** — Order 016-0792-01 **$340**

**Carrying Strap** - Order 346-0199-00 **$17**

**Dc Power** — Order 1107 Dc Inverter. For more information see page 281. **$475**

### RECOMMENDED PROBES

**P6131 Probe Package** — For use with CH 3 or CH 4. Order 010-6131-01 **$140**

**P6230** — 10X Bias/Offset Probe. Order 010-6230-01 **$395**

**P6133 Probe Package*1** — For use with 2445.

**Current Probes** — A6302, A6303, P6021, P6022. See pages 443 and 444 respectively.

**P6202A** — 10X FET Probe. Order 010-6202-03 **$680**

**P6602** — Temperature Probe. Order 010-6602-00. **$225**

**A6902B Isolator*1** — For floating measurements; see page 437 for complete description.

**A6901 Gound Isolator Monitor** — See page 438 for complete description. Order A6901 **$650**

**1 To order, contact your local Tektronix Sales Office.*

### RECOMMENDED CAMERAS

**C-30BP Option 01** — General Purpose. See page 412. **$1,524**

**C-5C Option 02** — Low Cost. See page 416. **$465**

### RECOMMENDED CARTS

**K212 Portable Instrument Cart** — For on-site mobility. See page 423. **$330**

**K117 Instrument Shuttle** — For site-to-site mobility. See page 423. **$265**

### SERVICE MANUALS

**2445** — Order 070-3829-00 **$20**

**2465** — Order 070-3831-00 **$20**

**Option 01** — Order 070-4182-00 **$10**

**Option 05** — Order 070-4630-00 **$10**

**Option 06/09** — Order 070-4640-00 **$15**

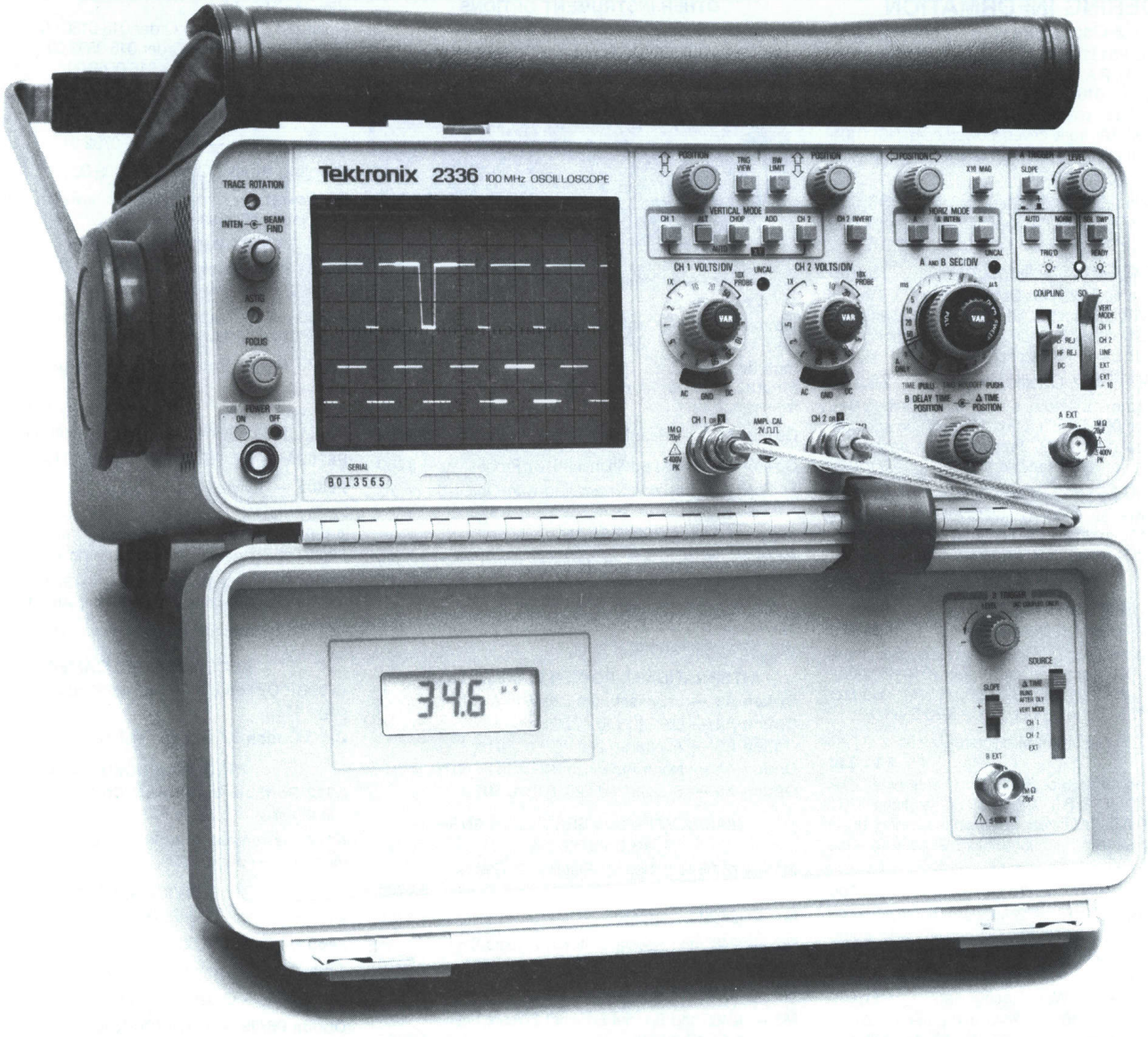
### SOFTWARE

**EZ-TEK 2400 Test Program Generator** — for 4041 and 2465 Special Editions or a 2445/2465 configured with Option 10. EZ-Tek 2400 is a versatile software development tool which allows nonprogrammers to easily develop automatic or semiautomatic computer-controlled test procedures. Order S49F101 **$400**

**Additional accessories begin on page 403.**

### SYSTEMS

**The 2465 Special Editions are also available configured into an automatic or semiautomatic measurements system MP 2903. This system is a combination of one of the Tektronix Special Editions (2465DVS, 2465DMS, or 2465CTS), 4041 Controller, a 4105A Terminal, EZ Test, and Test Program Generator. Together these can provide automatic or semiautomatic parametric results.**




# 2335/2336/ 2336YA/2337

**Dc to 100 MHz Bandwidth**

**5 mV/div to 5 V/div**

**5 ns/div Sweep Rate**

**Three Year Warranty—Five Year Option**

## TYPICAL APPLICATIONS

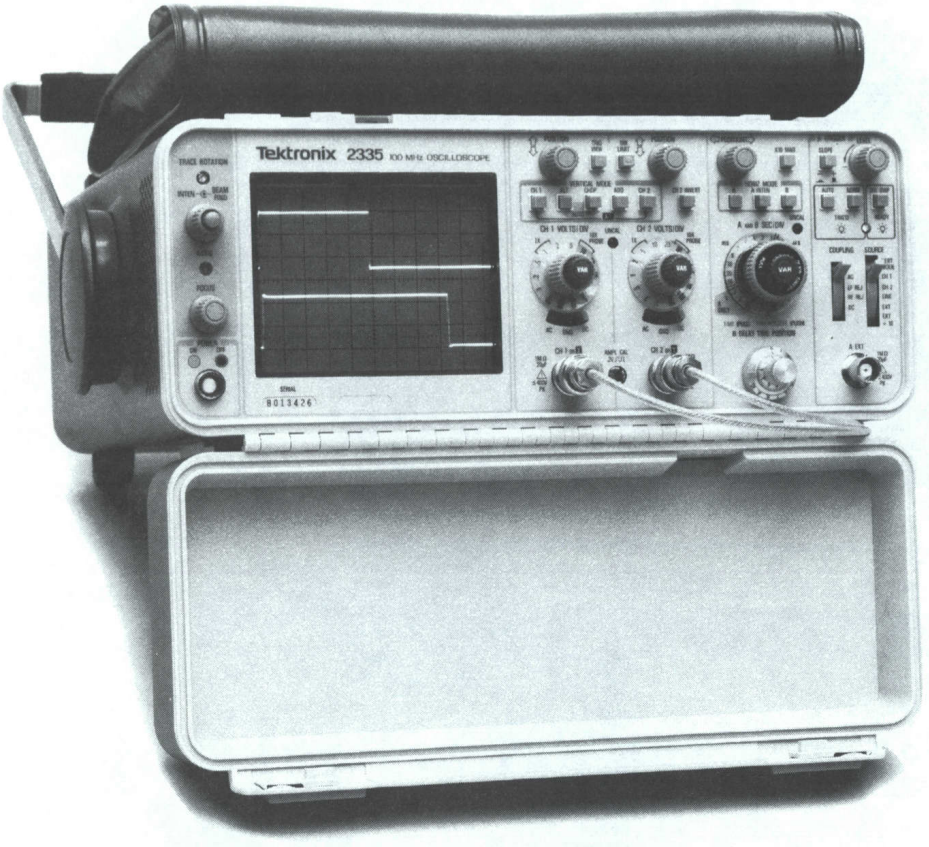
- **Rugged Field Service**
- **Computer Peripheral Service**
- **Communication Equipment Service**

Compact and lightweight for ultra-portability, these oscilloscopes are designed and built for on-site trouble-shooting. The 2335, 2336, 2336YA and 2337 are useful for high speed logic and digital applications. They feature an innovative and protective flip-top cover that doubles as a front panel with ΔTime on the 2336, 2336YA and ΔTime/DMM on the 2337 versions. The entire outside case of all four instruments is made of durable, one-piece aluminum and the front panels are coated with scratch resistant plastic. When the flip-tops are latched shut, the entire scope can withstand the abuse and heavy usage of field service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div. An internal delay line permits observation of the leading edge of a waveform. Variable sweep speeds range from 0.5 s/div to 50.0 ns/div and a 10X magnifier can increase the sweep rate to 5 ns/div. An auto-trigger mode allows triggering on waveforms with repetitive rates down to approximately 10 Hz. The sweep rate will run freely and provide a base line trace in the absence of an adequate trigger signal.

Many exterior features have been incorporated into these new ultra-portable scopes to make them fast and convenient to use. The CRT produces bright, high resolution traces that are readily visible in most light conditions. The ΔTime/DMM readouts are distinct, backlighted LCD (Liquid Crystal Displays) for clear viewing in any lighting condition. All knobs and switches have been located in logical groupings to avoid errors and delays during operation. And for the 2336, 2336YA and 2337 models, ΔTime and DMM display and controls are in the hinged, fliptop cover.

All four oscilloscopes come with detachable power cord, integral EMI shielding, and an accessories pouch. They are manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. This ruggedness meets MIL-T-28800C, Class 3 environmental requirements for aerospace and military qualification.




**2335**

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers a three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

The 2336YA version of the standard 2336 100 MHz Portable Oscilloscope has a 5000 hour elapsed time indicator installed, and also includes additional accessories and an extra set of manuals. The 2336YA has been accepted and specified by the U.S. Navy. 2300 Series products have National Stock Numbers. Check the Logistics Data Book for information.

## CHARACTERISTICS

The following characteristics are common to the 2335, 2336, 2236YA, and 2337 Oscilloscopes except where indicated.

### VERTICAL SYSTEM (TWO IDENTICAL CHANNELS)

**Bandwidth and Risetime**

| −15°C to +40°C | +40°C to +55°C |
|---|---|
| Dc to at least 100 MHz, 3.5 ns | Dc to at least 85 MHz, 4.15 ns |

**Bandwidth Limit** — 20 MHz by bandwidth limit switch.

**Lower −3 dB Point Ac Coupling** — 1X Probe: 10 Hz or less. 10X Probe: 1 Hz or less.

**Deflection Factor** — 5 mV/div to 5 V/div. 1-2-5 sequence. Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to at least 2 mV/div.

**Display Modes** — CH 1, CH 2, Add CH 2 (normal and inverted), Alternate, Chopped (≈275 kHz rate).

**Common-Mode Rejection Ratio** — For common-mode signals of 6 div or less. 2335, 2336, 2337: At least 10:1 at 50 MHz. 2336YA: At least 25:1 at 10 MHz; 10:1 at 100 MHz.

**Channel Isolation** — >100:1 at 25 MHz.

**Input R and C** — 1 MΩ ±2% paralleled by 20 pF ±10%.

**Maximum Input Voltage** — Ac or dc coupled, 400 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.

### HORIZONTAL SYSTEM

**Time Base A** — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

**Time Base B** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

**Variable Time Control** — Time base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

**Time Base A and B Accuracy*[1]**

| | +20°C to +30°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

*[1] *Full ten divisions*

**Display Modes** — A, A intensified by B, B delayed.

### CALIBRATED SWEEP DELAY

**Delay Time Range** — Continuous from 50 ns to at least 5 s after start of delaying sweep.

**Differential Time Measurement Accuracy*[1]**

| | +15°C to +35°C | −15°C to +55°C |
|---|---|---|
| 2335 | ±0.75% +0.015 major dial div | ±1.5% +0.015 major dial div |
| 2336/2336YA/ 2337 | ±1% of reading ±1 count | ±2.5% of reading ±1 count |

*[1] *2336YA Only: +10° C to +55° C is 2% of reading ±1 count.*

**Jitter** — One part or less in 20,000 (0.005%) of 10 times the A Sweep Time/Div setting.

### TRIGGERING

**A Trigger Mode** — Normal (sweep runs when triggered). Automatic (sweep free runs in absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs once on first triggering event after reset selector is pressed). LED indicates when sweep is triggered and when single sweep is ready.

**A and B Trigger Sensitivity**

| 2335, 2336, 2337 | Internal | External*[1] | External ÷10*[1] |
|---|---|---|---|
| 20 MHz | 0.3 div | 50 mV | 500 mV |
| 100 MHz | 1.1 div | 150 mV | 1.5 V |
| **2336YA** | | | |
| 25 MHz | 0.3 div | 50 mV | 500 mV |
| 100 MHz | 1.0 div | 150 mV | 1.5 V |
| 150 MHz | 1.1 div | 300 mV | 3 V |

*[1] *External B Trigger sensitivity is not applicable to the 2335.*

**Trigger Coupling** — Ac (−3dB 20 Hz), dc, LF REJ attenuates signals above 50 kHz. B Trigger coupling is ac only.

**A Trigger Hold Off** — Adjustable control permits a stable presentation of repetitive waveforms.

**ΔTime B Trigger Modes (2336, 2336YA and 2337 Only)** — Provides two intensified zones on the CRT trace for differential time measurements. Time difference between the two intensified zones is determined by B Delay Time Position and ΔTime Position controls, and is displayed on the LCD readout.

**Runs After Delay** — B Sweep starts immediately after the delay time selected by the Delay Time Position control and is independent of B trigger signal.

**Triggerable After Adjustable Delay Time** — The B Sweep Trigger is sourced from a composite of CH 1 and CH 2; CH 1 only, 2 only or from the Ext Trigger input connector.

**Jitter** — 2335, 2336, 2337: 1.0 ns or less at 100 MHz. 2336YA: 0.5 ns at 100 MHz.

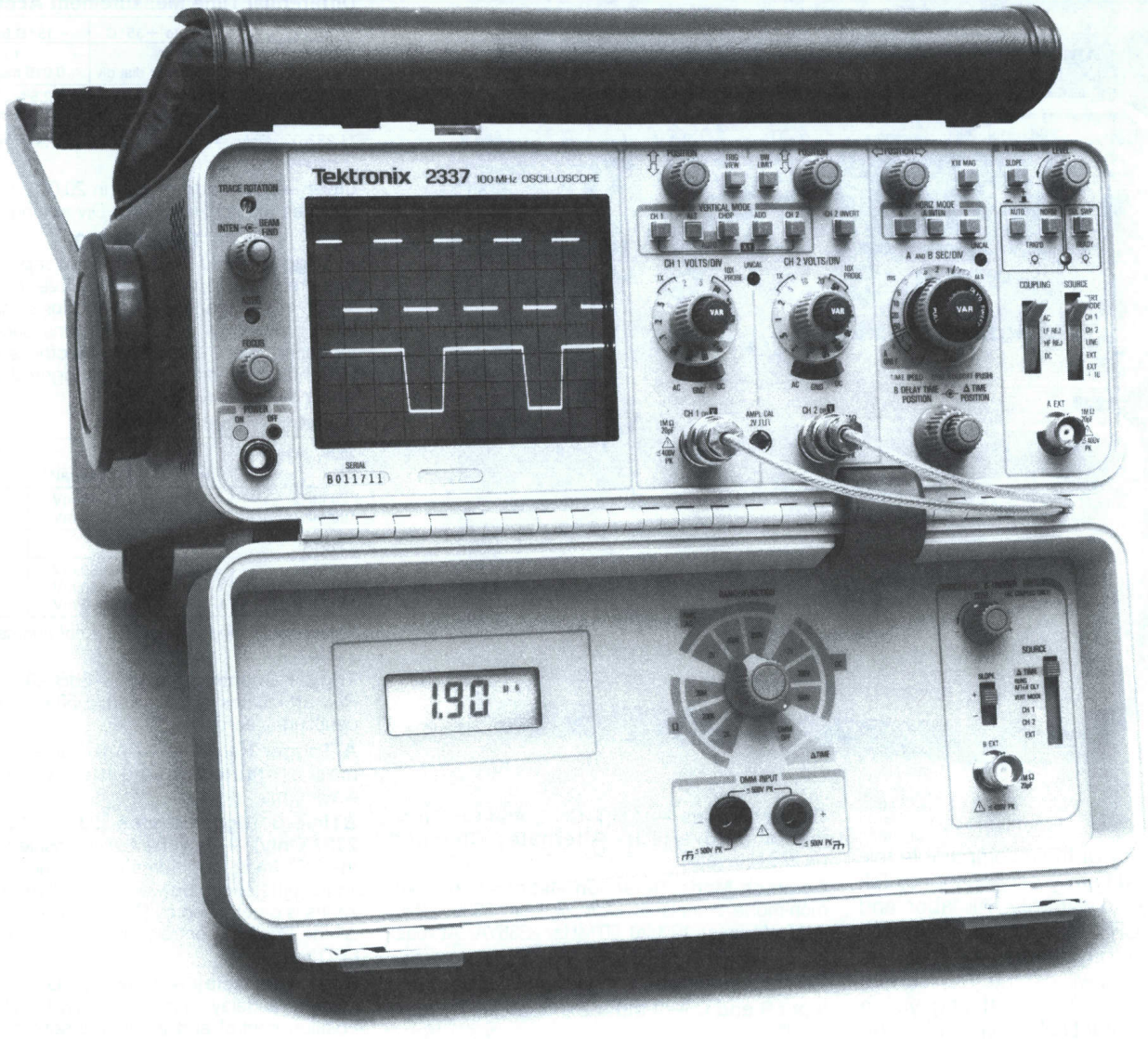
**A Trigger View** — A spring loaded pushbutton overrides other vertical controls to display the signal used to trigger the A Sweep. This control provides quick verification of the (trigger) signal and permits a time comparison between the vertical input signal and the trigger signal. Deflection Factor is 100 mV/div ±40% (1 V/div with Ext ÷ 10).

**Level and Slope** — Internal, permits selection of triggering at any point on positive or negative slope of vertical input signal. Level adjustment through at least ±1 V in Ext, through at least ±10 V in Ext ÷ 10.

**A Sources** — Vertical Mode, CH 1, CH 2, Line, Ext, Ext ÷ 10.

**B Sources (2336, 2336YA and 2337 Only)** — ΔTime runs after delay, Vertical Mode, CH 1, CH 2, Ext (all modes ac coupled).

**External Inputs** — R and C 1 MΩ ±10%, 20 pF ±30%. 400 V (dc + peak ac) or 500 V ac p-p at 1 kHz or less.




## X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical) —** 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±5% from 0°C to +40°C, accurate ±8% from −15°C to +55°C. X-axis bandwidth is dc to at least 2 MHz. Y-axis bandwidth is dc to at least 100 MHz. Phase difference between amplifiers is 3° or less from dc to 200 kHz.

## CRT AND DISPLAY FEATURES

**CRT —** 8 x 10 div (8 mm/div) display. Horizontal and vertical centerlines further marked in 0.2 div increments. Accelerating potential is 18 kV. GH (P31) phosphor.

**Graticule —** Internal, nonparallax, nonilluminated; markings for measurement of risetime.

**Beam Finder —** Compresses trace to within graticule area to locate an off screen signal.

**Z-Axis Input —** Positive-going, dc coupled signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 20 MHz.

## OTHER CHARACTERISTICS

**Amplitude Calibrator —** 0.2 V accurate ±1% from 0°C to +40°C, ±1.5% from −15°C to +55°C.

## POWER REQUIREMENTS

**Line Voltage Ranges —** 100 V ac to 132 V ac and 200 V ac to 250 V ac. Option 03 provides 90 V ac to 115 V ac or 180 V ac to 230 V ac.

**Line Frequency —** 48 Hz to 440 Hz.

**Maximum Power Consumption —** 35 W at 115 V, 60 Hz.

## ENVIRONMENTAL

The 2335 Oscilloscope meets all environmental requirements of MIL-T-28800C, Class 3. The 2336, 2336YA and 2337 Oscilloscopes meet the environmental requirements of MIL-T-28800, Class 3 except as indicated herein to avoid potential damage to the LCD readout.

**Temperature —** Forced air ventilation during normal operation.
2335: Operating is −15°C to +55°C. Nonoperating is −62°C to +85°C.
2335 Option 1R (Rackadapted): Operating temperature inside equipment rack must be between −15°C to +55°C and exhaust fan temperature must not exceed +65°C. Nonoperating is −62°C to +85°C.
2236/2237: Operating is −15°C to +55°C. Nonoperating is −40°C to +80°C.

**Altitude —** Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

**Vibration —** Test samples were subjected to sinusoidal vibration in the X, Y, and Z-axes with the frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute cycles for a duration of 15 minutes. Total displacement was 0.025 in p-p at (4 g's at 55 Hz).

**Humidity —** 2335 (Operating and Nonoperating): 95%, five cycles (120 hours), referenced to MIL-T-28800B Paragraph 3.9.2.2.
2336, 2336YA and 2337 (Operating): 90% (72 hours) at + 55°C.
2336, 2336YA and 2337 DMM (Operating): 90% (24 hours) at +35°C and 70% (24 hours) at +50°C.
2336, 2336YA and 2337 and DMM: 90% (72 hours) at 60°C.

**Shock —** Operating 50 g's, ½ sine, 11 ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

**Electromagnetic Compatibility (EMC) —** Test samples were found in compliance with the Class 3 requirements of MIL-STD-461B using procedural steps outlined in MIL-STD-462. (Increase RS03 requirements from 1 V/m to 10 V/m) for RE01, use 500 Hz to 30 kHz in place of 30 Hz to 30 kHz.

## PHYSICAL CHARACTERISTICS

| 2337 | 2335,2336,2336YA, Cabinet | | 2335 Option 1R Rackmount | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 274 | 10.8 | 483 | 19.0 |
| (with handle) | 315 | 12.4 | | |
| Height | | | 133 | 5.2 |
| (with feet/pouch) | 210 | 8.3 | | |
| (without pouch) | 135 | 5.3 | | |
| Depth | | | 378 | 14.9 |
| (with front cover) | 430 | 17.0 | | |
| (handle extended) | 528 | 20.8 | | |
| **Weights (2335)** | **kg** | **lb** | **kg** | **lb** |
| Net (without accessories or pouch) | 7.7 | 17.0 | 11.7 | 25.8 |
| Net (with accessories and pouch) | 8.6 | 19.0 | 12.6*1 | 27.8*1 |
| Shipping | 10.6 | 23.5 | 16.9 | 37.3 |
| **Weights (2336,2336YA,2337)** | **kg** | **lb** | **kg** | **lb** |
| Net (without accessories and pouch) | 8.0 | 17.6 | | |
| Net (with accessories and pouch) | 8.9 | 19.6 | | |
| Shipping | 10.9 | 24.1 | | |

*1 *No pouch for 2335 Option 1R.*

# 2337 with Digital Multimeter

## DC VOLTAGE

**Full Scale Ranges** — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 500 V.

**Resolution** — 100 μV at 200 mV full scale.

**Accuracy**

| | |
|---|---|
| +15°C to +35°C | Within ±0.15% of reading ±1 count |
| −15°C to +15°C | Add 0.01% for every °C below +15°C |
| +35°C to +55°C | Add ±0.01% for every °C above +35°C |
| >80% Relative Humidity | Add ±0.25% of reading ±3 counts |

**Input Resistance** — 10 MΩ ±0.25%.

**Rejection Ratio** — Normal-Mode: 60 dB minutes at 50 Hz and 60 Hz. Common-Mode: 100 dB minutes at dc, 60 dB minutes at 50 Hz and 60 Hz.

**Response Time** — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).

**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

## AC VOLTAGE

**Full Scale Ranges** — 2 V (autoranging to 200 mV); 200 V (autoranging to 20 V); and 350 V.

**Crest Factor** — (When peak voltage input is <3 times full scale) Six.

**Accuracy*1**

| | |
|---|---|
| +15°C to +35°C | Within ±3%, ±6 counts*1, 20 Hz to 25 kHz |
| −15°C to +15°C | Add ±0.05% for every °C below +15°C |
| +35°C to +55°C | Add ±0.05% for every °C above +35°C |

*1 *Nonsinewaves: Derate below 50 Hz. For crest factors >3, add +0, −1% of reading.*

**Input Impedance** — Resistance 10 MΩ ±0.25% in series with input blocking cap. Capacitance (20 V, 200 V, and 350 V range) <150 pF; (200 mV, 2 V range) <220 pF.

**Common-Mode Rejection Ratio** — 60 dB minimum at 50 Hz and 60 Hz, 2 V range; 53 dB minimum at 50 Hz and 60 Hz, 200 V and 300 V range.

**Response Time** — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).

**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

## RESISTANCE

**Full Scale Ranges** — 2 kΩ (autoranging to 200 Ω); 200 kΩ (autoranging to 20 kΩ); 20 MΩ (autoranging to 2 MΩ).

**Resolution** — 0.1 Ω.

**Accuracy**

| | |
|---|---|
| +15°C to +35°C | Within ±0.5% ±2 count +0.4 Ω |
| −15°C to +15°C | Add 0.05% for every °C below +15°C |
| +35°C to +55°C | Add 0.05% for every °C above +35°C |
| >80% Relative Humidity | Add ±1% of reading ±8 counts |

**Response Time** — <4 s.

**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

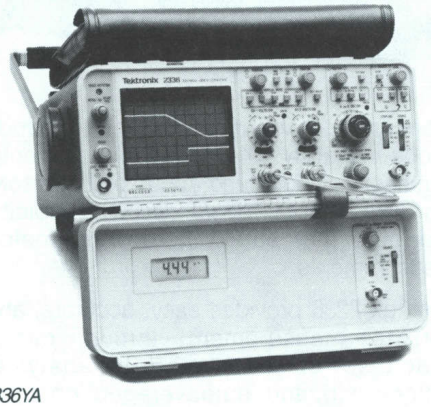
## ORDERING INFORMATION

**2335 Oscilloscope** **$3,390**

**Includes:** Two P6108A 10X Probes (010-6108-13); accessory pouch (016-0674-00); zip lock accessory pouch (016-0537-00); clear CRT implosion shield (337-2781-00); installed, blue CRT implosion shield (337-2760-00); two 1 A fuses (159-0022-00); ½ A fuse (159-0025-00); power cord (161-0104-00); operator manual (070-4115-00).

**2336 Oscilloscope with ΔTime** **$3,690**

**Includes:** Same as 2335, instruction manual (070-4117-00) instead.



*2336YA*

*The 2336YA has been accepted and specified by the U.S. Navy. Also see page 277.*

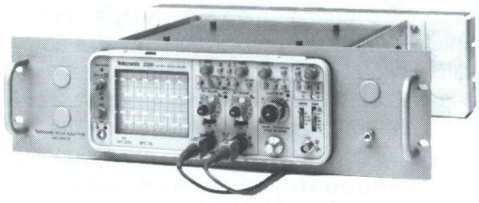
**2336YA Oscilloscope with ΔTime, Elapsed Time Meter, Extra Accessories and Manuals** **$3,890**

**Includes:** Same as 2336 plus P6101A probe (010-6101-13); three probe tip adaptors (103-0051-01); three spring tip adaptors (206-0060-00); operator manual (070-5010-00); service manual (070-5011-00).

**2337 Oscilloscope with ΔTime and DMM** **$3,990**

**Includes:** Same as 2335, instruction manual (070-4119-00) instead.

### OPTIONS



*Rackmount 2335 Option 1R*

**Option 1R** — (2335 only) Rack Conversion. **+$325**

**Option 03** — 100 V/200 V, ac nominal, 48 Hz to 440 Hz. **NC**

### CONVERSION KIT

**Rackmount Conversion** — (2335 only.)
Order 016-0468-00 **$310**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

### *WARRANTY-PLUS* SERVICE PLANS

SEE PAGE 458

**M1** — (2335) 2 Calibrations. **+$145**
**M1** — (2336/2336YA) 2 Calibrations. **+$160**
**M1** — (2337) 2 Calibrations. **+$180**
**M2** — (2335) +2 Years Service. **+$140**
**M2** — (2336/2336YA) +2 Years Service. **+$160**
**M2** — (2337) +2 Years Service. **+$180**
**M3** — (2335) +2 Years Service & 4 Calibrations. **+$410**
**M3** — (2336/2336YA) 2 Years Service & 4 Calibrations. **+$470**
**M3** — (2337) 2 Years Service & 4 Calibrations. **+$510**
**M4** — (2335) 5 Calibrations. **+$390**
**M4** — (2336/2336YA) 5 Calibrations. **+$445**
**M4** — (2337) 5 Calibrations. **+$480**
**M5** — (2335) 9 Calibrations +2 Years Service. **+$825**
**M5** — (2336/2336YA) 9 Calibrations +2 Years Service. **+$940**
**M5** — (2337) 9 Calibrations +2 Years Service. **+$1,025**

## OPTIONAL ACCESSORIES

*The 1106 fits under the scope. The 1107 attaches to the rear.*

*See page 281 for complete descriptions on power supplies.*

**Battery Pack** — Order 1106 **$1,235**

**Dc Power** — Order 1107 **$475**

**A6902B Isolator** — For floating measurements see page 437 for complete description.
Order A6902B **$1,995**

### RECOMMENDED PROBES

See probe section for complete descriptions, page 425.

**P6108A** — 10X probe. Order 010-6108-13 **$100**
**P6202A** — 10X FET probe. Order 010-6202-03 **$680**
**P6022** — Current probe. Order 015-0135-00 **$475**

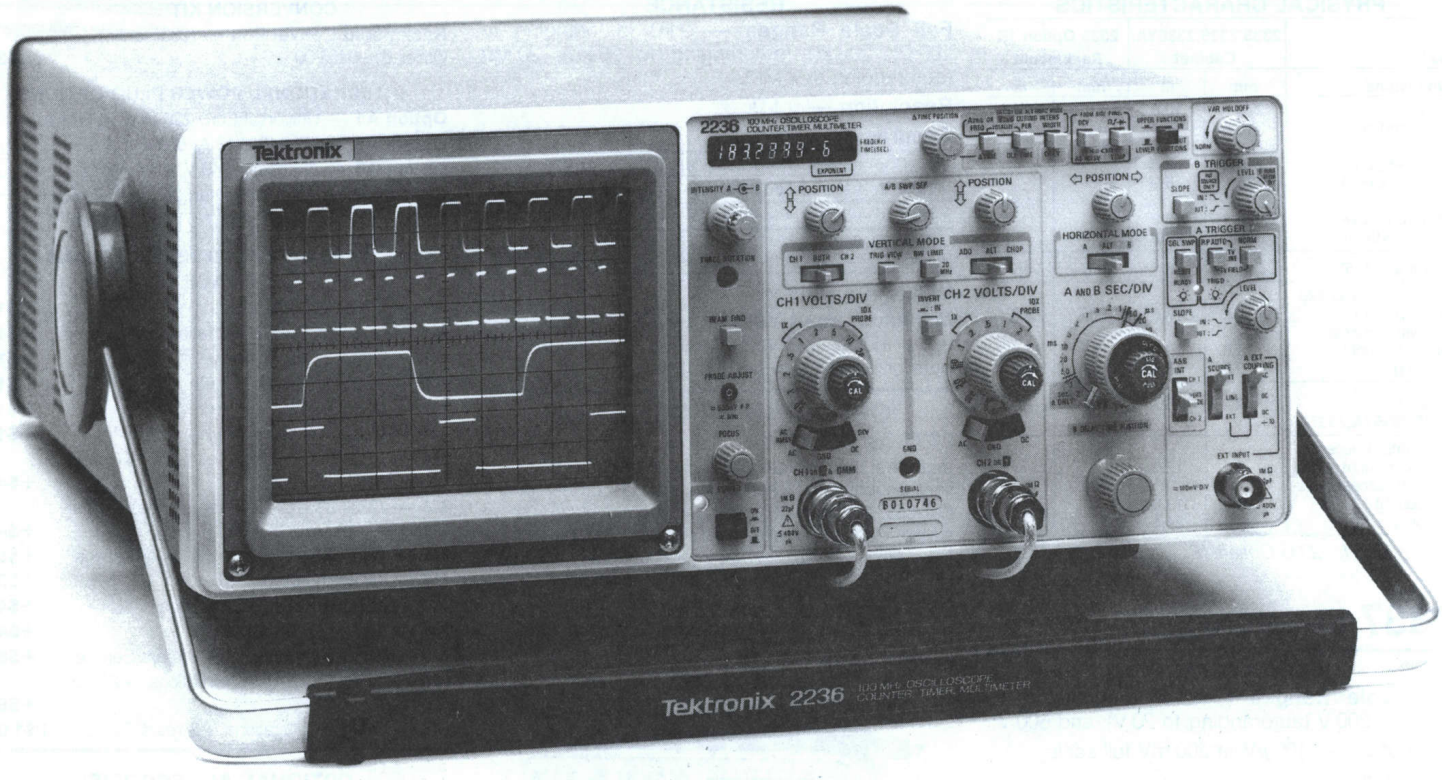
### RECOMMENDED CAMERA

**C-5C Option 04** — Includes 016-0359-01 adaptor and flash (camera mount not provided). See page 416. **$495**

### RECOMMENDED CARTS

**K212 Portable Instrument Cart** — For on-site mobility. See page 423. **$330**

**K117 Instrument Shuttle** — For site-to-site mobility. See page 423. **$265**




# 2236

**Dc to 100 MHz Bandwidth**

**Integrated Counter/Timer/DMM**

**Light Weight, Easy to Use**

**2 mV Sensitivity**

**5 ns/div Sweep Rate**

**100 MHz Counter**

**Gated Counter Measurements**

**Δ Time**

**Channel 1 Ac and Dc Volts**

**Three Year Warranty—Five Year Option**

## TYPICAL APPLICATIONS

* **Digital Design and Testing**
* **Field Service**
* **Amplifier Design and Testing**

The 100 MHz 2236 introduces a new concept in waveform measurement: a 100 MHz counter/timer/DMM, integrated into the scope's vertical, horizontal and trigger systems. This convenient feature simplifies setup (by allowing consolidated setups and combinations of measurements), heightens measurement confidence and expands scope versatility. The 2236 replaces mental gymnastics and round-about problem-solving with simple, direct, accurate, digital readouts that supplement your analog measurements.

The Tek 2236 provides easy, accurate, and versatile measurements through microprocessor-driven waveform analysis. Autoranged and autoaveraged counter/timer measurements are made on the signal triggering the A sweep, or in gated modes on the signal triggering the B sweep. Autoranged DMM measurements are made through floating DMM side inputs and uprange at 5000 counts. Channel 1 voltage measurements made on Channel 1 signal include: dc, relative dc, relative and true ac RMS voltage. Self-testing includes power-on and user interactive routines.

The 2236 uses intensified markers onscreen to define the area to be measured on a burst or short-duration pulse train. Gated counter measurements are made via the B trigger with operator prompting and automatic, digital readout of results. (See Figures 1, 2, 3). With period averaging the 2236 can make low frequency measurements instantly, in contrast to the several seconds delay encountered on conventional counter/timers.

The scope and DMM can be applied simultaneously, with concurrent CRT and digital readout displays. The same probe feeds data to the scope and provides information to the DMM, thus eliminating tangled leads and extra setup time required to obtain true ac RMS or dc voltage readings (see Figure 6).

DMM auto ranging simplifies setup. An ohmmeter range of 2 GΩ—a hundred times the range of most such devices—allows service technicians to quickly pinpoint even small amounts of transformer leakage, or designers to accurately check the insulating property of capacitors (see Figure 9).

Frequency, period and width measurements are push-button simple, with accuracies to 0.001% and beyond. On-screen operator prompts further ensure fail-safe setup (see Figure 7).

An audible, automatic diode/junction detection, and continuity signal saves both time and interpretation errors by allowing the operator to concentrate on probing rather than on observing the front panel (see Figure 8).

In strong testimony of the incomparable reliability of the 2000 Family of oscilloscopes, Tek offers a three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

See page 275 for Characteristics.

## Gated Frequency Measurement

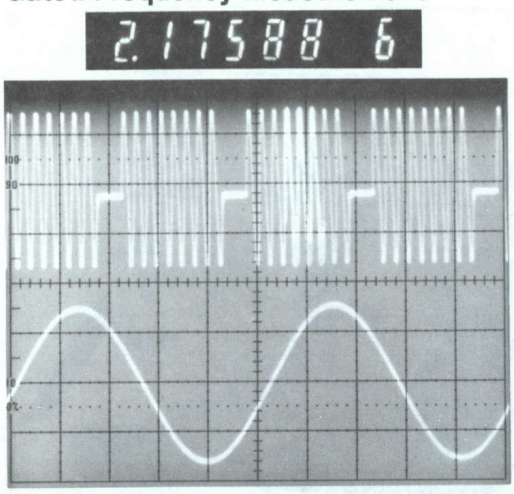



*Figure 1. With the B sweep triggered, the frequency within the intensified zone on the A sweep is measured.*

## Gated Period Measurement

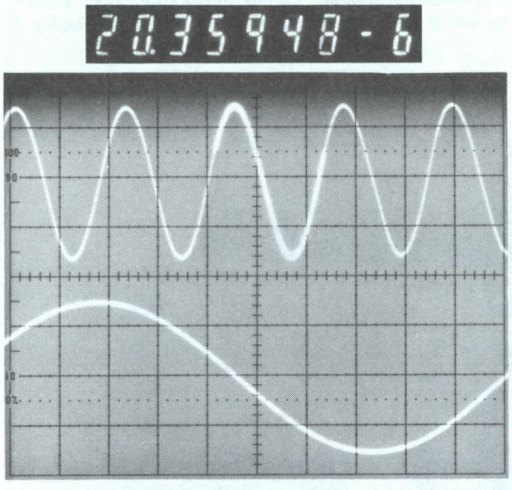



*Figure 2. With the B sweep triggered, the period within the intensified zone on the A sweep is measured.*

## Gated Width Measurement

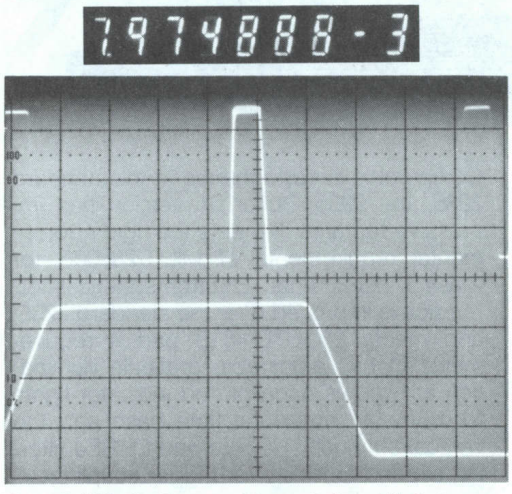



*Figure 3. With the B sweep triggered, the width to be measure is within the intensified zone and polarity is selected by the B trigger slope control.*

## Gated Totalize Measurement

*With the B sweep triggered, the events within the intensified portion of the A sweep are totalized. A single events count can be made using single sweep.*

## Delay Time Measurement

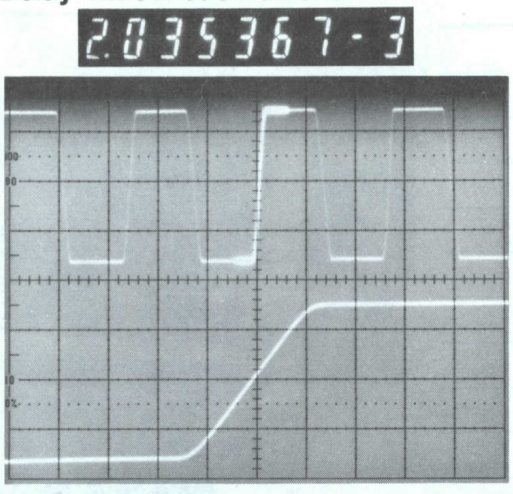



*Figure 4. Delay time is measured from the start of the A sweep to the start of the intensified zone.*

## Delta Time Measurement

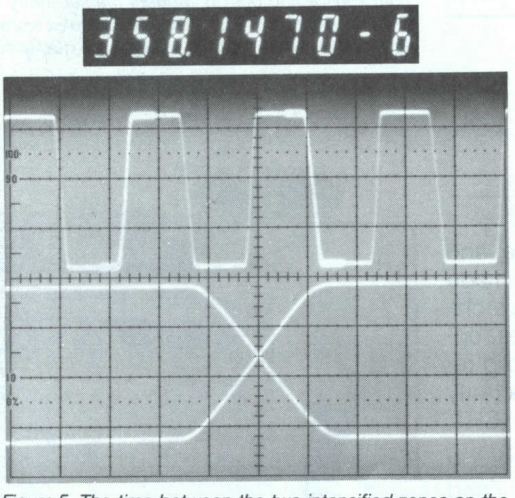



*Figure 5. The time between the two intensified zones on the A sweep is measured with up to 10-picosecond resolution.*

## Channel 1 Volts Measurement

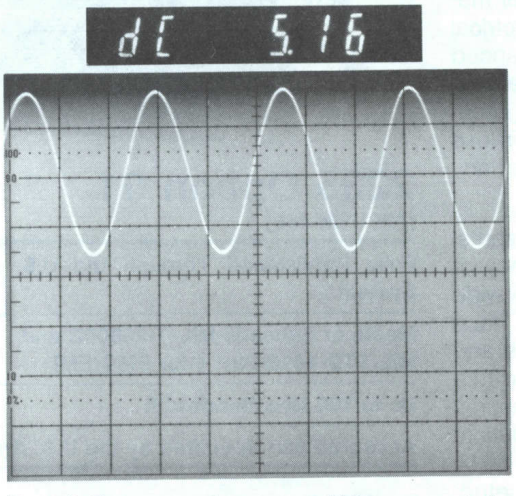



*Figure 6. The average dc or true ac RMS component of a waveform is measured directly through channel 1 or from the floating DMM input.*

## Continuity Measurement

*Resistances >5 Ω, the message "OPEN" is displayed. <5 Ω, a tone is generated and the message "SHORT" is displayed.*

## Operator Prompting

*Figure 7. Error messages and prompts make counter/timer/DMM measurements easier.*

## Diode Detection and Test

*Figure 8. Automatic junction detection during normal resistance measurements first displays "DIODE" and then the forward voltage drop to 1%.*

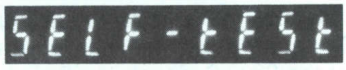
## Extended Range Resistance Measurement

*Figure 9. 0 Ω (with 0.01 Ω resolution) to 1.99 GΩ, to find hard-to-trace problems like leaky caps or bad transformers.*

## Temperature Measurement

*With optional P6602 Probe: From −62° C to +230° C (−80° F to +446° F); resolution to 0.1° (either range).*

## Microprocessor Diagnostics




*Automatic power-up and user-interactive diagnostic routines simplify CTM service.*

## Accurate Time Measurement

*Time base error only 10 ppm (0.001%) standard, and only 0.5 ppm (0.00005%) with optional temperature compensated crystal oscillator.*

## Measurement Ease and Accuracy

*See the measurement you make on the CRT, read the result with digital accuracy on the 9-digit display.*

For further information and characteristics see page 275.

# 2235

**Dc to 100 MHz Bandwidth**

**Light Weight**

**Easy to Use**

**2 mV Sensitivity**

**Advanced Trigger System**

**Trigger View**

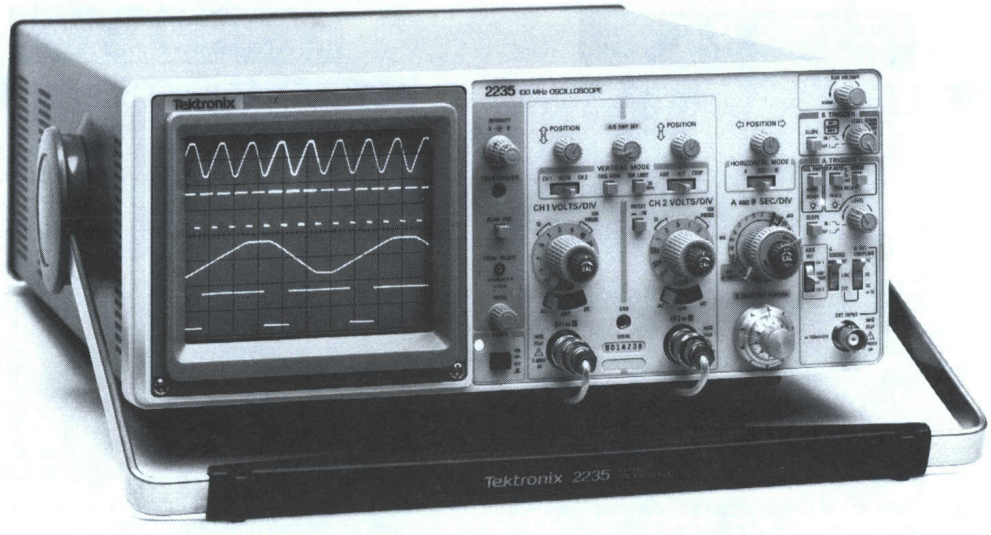
**5 ns/div Sweep Rate**

**Delayed Sweep Measurements**

**Large, Bright CRT**

**10X Probes Included**

**Three Year Warranty—Five Year Option**




*Features like rugged design, light weight and an easy-to-learn front panel make the 2235 an ideal service scope. In both service and design, it offers the sensitivity for low level measurements and sweep rates for fast logic families, plus 10:1 variable holdoff range for complex word triggering. And at the bottom line, it offers the price and reliability to significantly lower the cost of owning a quality scope.*

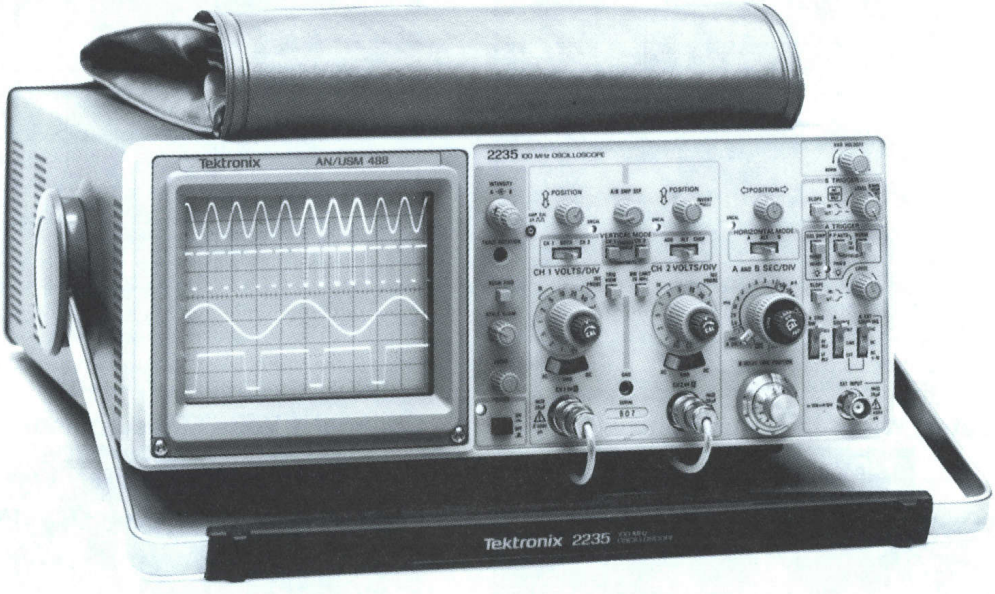
## TYPICAL APPLICATIONS

* **Field Service**
* **Design**
* **Component Testing**

The 100 MHz 2235 offers high value and high performance. The low price is made possible by the 2200 Series innovative architecture. Yet it has the needed features, operational simplicity and—not least—solid reliability. All backed by a three-year warranty on all parts and labor, including the CRT, excluding probes.

The 2235 ensures measurement quality and reliability while reducing instrument cost. Tek started with the innovative architecture of the 2200 Series: fewer boards, fewer mechanical parts, less cabling and electrical connectors. This approach, plus advanced circuit design and a focus on essential features, has led to a scope that's more accurate, more reliable, lighter and more serviceable—and simpler to use—than any other 100 MHz scope.

The 2235 delivers 2% vertical and horizontal accuracy in normal operation. Accuracy of 3% or better is maintained across a wide range of environmental extremes. Trace noise, chop noise, vertical aberrations and sweep interference have been reduced to a minimum. Delay jitter of 1:20,000 ensures excellent timing measurement resolution. Triggering is sensitive to 0.3 div at 10 MHz. There's a trigger view for simplifying setup; single sweep for photographing transients; bandwidth limit for noisy environments; and a bright, high-resolution 14 kV dome mesh CRT.




# 2235 Option 01

**(AN/USM-488)**

**Fully Provisioned Through the U.S. Army System**

**Meets or Exceeds MIL-T-28800C and MIL-STD-461B Part 4 for EMC/EMI**

**Dc to 100 MHz Bandwidth**

**Accepted and Specified by the U.S. Army**

The 2235 Option 01 is accepted and specified by the U.S. Army. If you're involved in designing and specifying systems for the U.S. Army, here is a 100 MHz oscilloscope that should top your support equipment lists.

Comparable in performance to the standard 2235, the 2235 Option 01 version has impressive features. It meets the rigid environmental requirements of MIL-T-28800C for Class 5 instruments. Electromagnetic interference is improved over the standard 2235, and meets MIL-STD-461B part 4 requirements. It has adjustable graticule illumination as well as uncalibrated indicator lights for both the horizontal time base and the vertical channels. HF REJ and LF REJ filtering expand flexibility for trigger coupling.

For your convenience we've also included a protective front-panel cover, accessory pouch, P6101A 1X 2-meter probe, binocular viewing hood, BNC T connector, BNC male-to-binding post, two IC grabber tips and a service manual.

# CHARACTERISTICS

The following electrical characteristics are common to the 2236, 2235, and 2235 Option 01 except where noted.

## VERTICAL SYSTEM (TWO IDENTICAL CHANNELS)

**Bandwidth (−3dB) and Risetime —** 100 MHz and 3.5 ns, derated to 90 MHz at 2 mV/div and outside 0°C to +35°C. Bandwidth Limit: 20 MHz ±10%.

**Deflection Factor —** 2 mV to 5 V/div at ±2%. Accuracy derated ±3% outside +15°C to +35°C (+10°C to +35°C, 2235 Option 01). Continuously variable between steps by at least 2.5:1.

**Step Response Aberrations —** 2235 and 2235 Option 01: +4%, −4%, 4% p-p (2 mV to 0.5 V/div).
2236: +4%, −4%, 4% p-p (5 mV to 0.5 V/div), +5%, −5%, 5% p-p (2 mV/div).

**Display Modes —** CH 1, CH 2, CH 2 Invert, Add, Alternate, Chop (500 kHz).

**Common-Mode Rejection Ratio —** At least 10:1 at 50 MHz for signals of 6 div or less (10:1 at 80 MHz 2235 Option 01).

**Input R and C —** 2235 and 2235 Option 01: 1 MΩ, 20 pF. 2236: 1 MΩ, 22 pF.

**Maximum Input Voltage (Ac and Dc Coupled) —** 400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

**Channel 1/Channel 2 Isolation —** 100:1 at 50 MHz.

## HORIZONTAL SYSTEM

**Sweep Rate —** A Time Base: 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X Mag: 5 ns/div. B Time Base: 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X Mag: 5 ns/div.

**Sweep Linearity —** ±5% over any two of center eight divisions.

**Accuracy —**

| | +15°C to +35°C*1 | 0°C to +50°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

*1 *+10°C to +35°C for 2235 Option 01.*

**Display Modes —** A, Alternate (A Intensified and B Delayed) and B.

## CALIBRATED SWEEP DELAY

**Delay Time Range —** Continuously variable with 10-turn control from <0.5 +300 ns to >10 div.

**Differential Delay Time Accuracy (2235 and 2235 Option 01) —** ±1% (+15°C to +35°C); ±2% (0°C to +50°C).

**ΔTime Measurement Accuracy (2236) —** Max accuracy equal to time base accuracy ±50 ps. Time Base Accuracy With Standard Oscillator: 10 ppm (0.001%); with Option 14 TCXO (Temperature-Compensated Crystal Oscillator): 0.5 ppm (0.00005%).

**Delay Jitter —** 2236: 10,000:1 (0.01%). 2235 and 2235 Option 01: 20,000:1 (0.005%).

## TRIGGERING

### A Trigger Sensitivity

| 2235 & 2235 Opt 01 | Internal | External (p-p volts) |
|---|---|---|
| 10 MHz | 0.3 div*1 | 35 mV |
| 60 MHz | 1.0 div | 120 mV |
| 100 MHz (2235) | 1.5 div | 200 mV |
| 100 MHz (2235 Opt 01) | 1.5 div | 150 mV |
| **2236** | | |
| 10 MHz | 0.35 div | 40 mV |
| 60 MHz | 1.2 div | 150 mV |
| 100 MHz | 1.5 div | 250 mV |
| **2236 CTM** | | |
| 10 MHz | 0.5 div | 50 mV |
| 60 MHz | 1.5 div | 160 mV |
| 100 MHz | 2.0 div | 300 mV |

### B Trigger (Internal Only) Sensitivity

| | 10 MHz | 60 MHz | 100 MHz |
|---|---|---|---|
| 2235 & 2235 Opt 01 | 0.35 div | 1.0 div | 1.5 div |
| 2236 | 0.4 div | 1.2 div | 1.5 div |
| 2236 CTM | 0.5 div | 1.5 div | 2.0 div |

*1 *0.35 for 2235 Option 01.*

**TV Trigger Sensitivity —** TV Field: 1.0 div of composite sync. TV Line: 0.3 div (2235); 0.35 div (2236 and 2235 Option 01).

**Bandwidth Limiting —** 20 MHz when bandwidth limit switch depressed.

**High Frequency Reject —** (2235 Option 01 only) Attenuates signals above 40 kHz.

**Low Frequency Reject —** (2235 Option 01 only) Attenuates signals below 40 kHz.

**Trigger System Operating Modes —** Normal, p-p automatic, TV line, TV field, and single sweep.

**Trigger View System —** Same deflection factors as vertical channels with internal sources; 100 mV/div with ac and dc external, and 1 V/div with dc ÷ 10 external. Accuracy is ±20%. Delay difference between trigger view (EXT input) and either vertical channel is <2.0 ns.

**External Trigger Input —** Coupling: Ac, dc, or dc ÷ 10.

**Variable Holdoff Control —** Increases A sweep holdoff time at least 10:1.

## X-Y OPERATION

**Deflection Factors —** Same as scope's vertical system with the V/div switch in calibrated detent.

**Accuracy**

| | Y-Axis | X-Axis |
|---|---|---|
| +15°C to +35°C | ±2% | ±3% |
| 0°C to +50°C | ±3% | ±4% |

**Bandwidth —** Y-Axis: same as scope's vertical system. X-Axis: 2.5 MHz.

**Phase Difference Between X-Axis and Y-Axis Amplifiers —** ±3° from dc to 150 kHz with dc coupled inputs.

## CRT AND DISPLAY FEATURES

**CRT —** 8 cm x 10 cm display; internal unilluminated graticule (2235 Option 01 is illuminated.) Accelerating potential is 14 kV. GH (P31) phosphor standard.

**Controls —** Beam Finder, Focus, Separate A and B Sweep Intensity, Trace Rotation. 2235 Option 01 also has Variable Scale Illumination.

**Z-Axis Input —** Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation; dc to 20 MHz.

## OTHER CHARACTERISTICS

**Probe Adjust Signal —** (2235/2236) Squarewave, 0.5 V ±5%, 1 kHz ±20%.

**Amplitude Calibrator —** (2235 Option 01 only) Squarewave, 0.5 V ±2%, 1 kHz ±20%.

## POWER REQUIREMENTS

**Line Voltage Range —** 90 V ac to 250 V ac. (No line switches or fuse changes needed.)

**Line Frequency —** 48 Hz to 440 Hz.

**Maximum Power Consumption —** 2235: 40 W, 70 V A. 2236: 60 W, 110 V A.)

**Dc Operation —** 12 V to 30 V available with 1105, 1106, and 1107.

## ENVIRONMENTAL

**Ambient Temperature —** Operating: 0°C to +50°C, (except 2236 CTM ac RMSV, DCV, and Ω Modes: 0°C to +40°C). Nonoperating: −55°C to +75°C.

**Altitude —** Operating: To 4600 m (15,000 ft). Maximum operating temperature decreased 1°C/1,000 ft 5,000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration —** Operating: 15 minutes along each of the major axes. 0.015 in p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for 10 minutes at 55 Hz (2.4 g's at 55 Hz).

**Humidity —** Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800C, Paragraph 4.5.5.1.2.2.

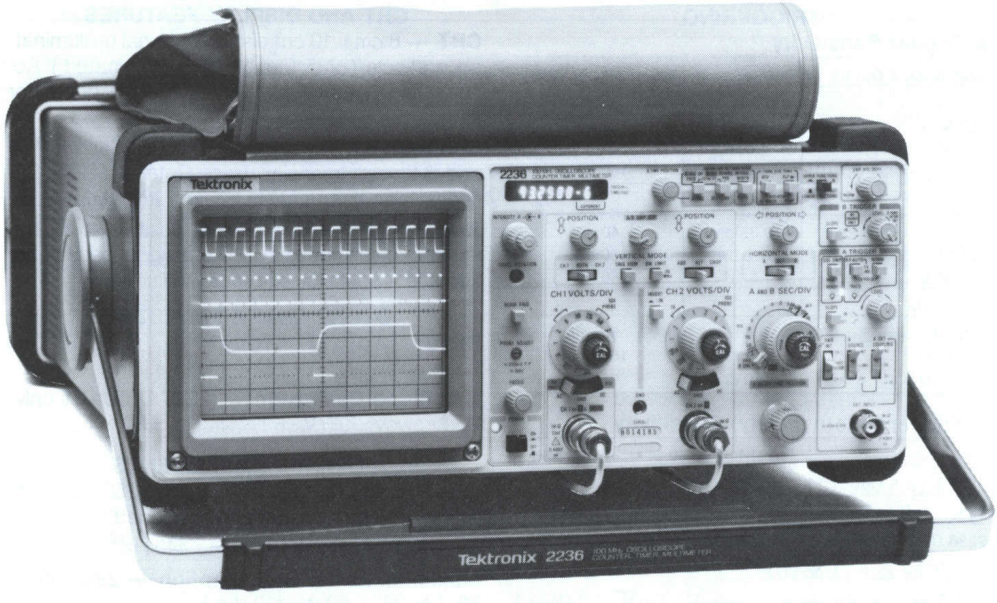
**Shock —** Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

**EMC —** Meets Class B requirements per VDE 0871B for radiated and conducted emission. 2235 Option 01 AN/USM 488 Only: Meets requirements of MIL STD-461B Part 4, CE03, CS01, CS02, CS06, RE02 (to 1 GHz), and RS03 (1 V/meter to 1 GHz).

## PHYSICAL CHARACTERISTICS

| | 2235 and 2235 Opt 01 | | 2236 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width*1 | 328 | 12.9 | 328 | 12.9 |
| Height*3 | 137 | 5.4 | 137 | 5.4 |
| Depth*2 | 440 | 17.3 | 440 | 17.3 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 6.1 | 13.5 | 7.3 | 16.2 |

*1 *Without handle.*
*2 *Without front cover.*
*3 *2235 Option 01 height with pouch is 150 mm (5.9 in).*




## 2236 Counter/Timer/Multimeter

### CHARACTERISTICS

The following characteristics are unique to the 2236.

**Time Base Accuracy** — Standard: 10 ppm (0.001%). With Option 14 TCXO: 0.5 ppm (0.00005%).

**Frequency** — Range: ⩽0.2 Hz to ⩾100 MHz. Maximum Resolution: 0.00001 Hz. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1*2

**Period** — Range: ⩾5 s to ⩽10 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy. Can be gated.*1*2

**Width** — Range: ⩾5 s to ⩽5 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±10 ns. Can be gated.*1*2

**Delay Time** — Range: ⩾2.5 s to ⩽500 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±20 ns.*2

**ΔTime** — Range: ⩾2.5 s to ⩽1 ns. Maximum Resolution: 10 ps. Maximum Accuracy: Equal to time base accuracy ±50 ps.*2

**Totalize** — Over 8,000,000 events. Can be gated.

**Dc Volts** — Range: 0 V to 500 V. Maximum Resolution: 100 μV. Accuracy: ± 0.1%. Input: Through side DMM leads.*2

**RMS Ac Volts** — Ac Coupled: True RMS with 20 Hz to 20 kHz frequency range. Range: 0 V to 350 V. Maximum Resolution: 100 μV. Accuracy: ± 1.0%. Input: Through side DMM leads.*2

**CH 1 Volts** — Measures average dc voltage (with CH 1 dc coupling) or true RMS voltage (with CH 1 ac coupling); 1X/10X ranged by coded probes: Single Sweep button zeros display and permits relative dc and ac RMS measurements. Range, Dc and Ac Volts: 0 V to 50 V (500 V dc/350 V ac with P6121 10X Probe). Maximum Resolution, Dc and Ac Volts: 100 μV (1 mV with P6121). Maximum Accuracy, Dc Volts (18°C to 28°C): ±0.3% with 1X probe, ±0.5% with 10X probe. Maximum Accuracy, Ac Volts with 1X probe (18°C to 28°C): ±2%, 50 Hz to 100 Hz, ±1%, 100 Hz to 20 kHz. Maximum Accuracy, Ac Volts with 10X Probe: ±2%, 20 Hz to 20 kHz, with proper probe compensation.*2

**Resistance** — Range: 0 Ω to 1.99 GΩ. Maximum Resolution: 0.01 Ω. Accuracy: To 0.15%. Automatic diode detection displays forward voltage drop to ±1%; continuity mode activates tone if resistance is <5 Ω.*2

**Temperature** — Uses Optional Tektronix P6602 Temperature Probe. Temperatures in C or F selected with Freq/ΔTime button. Range: −62°C to +230°C (−80°F to +446°F). Resolution: To 0.1° (either range). Accuracy: To ±2% of reading ±1.5°C; ±2% of reading ±2.70°F.

**Multimeter Inputs** — Isolated from oscilloscope ground. Input Z: 10 MΩ. Maximum Input Voltage: 500 V (dc + peak ac), for all functions.

**1 Ranges, resolutions, and accuracies can be degraded due to gating errors and a smaller number of automatic averages made during a gated frequency, period, or width measurement. For complete formula specifications see operator's manual.*

**2 For complete accuracy and resolution error formula specifications see operator's manual.*

### ORDERING INFORMATION

**2236** Oscilloscope with Counter/Timer/Multimeter **$2,650**
**Includes:** Two P6121 10X voltage probes (010-6121-01); DMM leads; reference guide; operator manual (070-4205-00).

**2235** Oscilloscope **$1,750**
**Includes:** Two P6122 10X voltage probes (010-6122-01); operator manual (070-4207-00).

**2235 Option 01** Oscilloscope (AN/USM-488) Order 2235L **$1,995**
**Includes:** Two P6122 10X Voltage Probes (010-6122-01); P6101A 1X Voltage Probe (010-6101-13); viewing hood (016-0566-00); BNC T-connector; BNC male to binding post; front panel cover; accessory pouch; two grabber tips; operator manual (070-4976-00); service manual (070-4977-00).

#### OPTIONS

**Option 02** — (2236 only) Front panel cover and accessory pouch. **+$47**

**Option 14** — (2236 Only) TCXO Temperature-Compensated Crystal Oscillator, 0.5 ppm accuracy. **+$295**

**Option 33** — (2235, 2236 only) Travel Line Package. See page 280. **+$200**

#### CONVERSION KITS

**Rackmount Adaptor** — See page 280
(2335) Order 016-0466-00 **$110**
(2235 Option 01) Order 016-0833-00 **$150**
(2236) Order 016-0015-00 **$230**

**Travel Line Package Retrofit Kit** — See page 280.

**TCX0 Retrofit Kit** — (2236 only) Temperature compensated crystal oscillator, 0.5 ppm accuracy. Order 040-1136-00 **$365**

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz. Order 020-0859-00.

**Option A2** — UK 240 V/13 A, 50 Hz. Order 020-0860-00.

**Option A3** — Australian 240 V/10 A, 50 Hz. Order 020-0861-00.

**Option A4** — North American 240 V/15 A, 60 Hz. Order 020-0862-00.

**Option A5** — Switzerland 220 V/10 A, 50 Hz. Order 020-0863-00.

#### *WARRANTY-PLUS* SERVICE PLANS — SEE PAGE 457

**M1** — (2235/2235 Option 01) 2 Calibrations. **+$135**
**M1** — (2236) 2 Calibrations. **+$160**
**M2** — (2235/2235 Option 01) +2 Years Service. **+$125**
**M2** — (2236) +2 Years Service. **+$150**
**M3** — (2235/2235 Option 01) 2 Years Service & 4 Calibrations. **+$380**
**M3** — (2236) 2 Years Service & 4 Calibrations. **+$450**
**M4** — (2235/2235 Option 01) 5 Calibrations. **+$385**
**M4** — (2236) 5 Calibrations. **+$425**
**M5** — (2235/2235 Option 01) 9 Calibrations +2 Years Service. **+$805**
**M5** — (2236) 9 Calibrations +2 Years Service. **+$900**

### OPTIONAL ACCESSORIES

**Front Panel Cover and Accessory Pouch*1** — Order 020-0672-02 **$47**

**Front Panel Cover*1** — Order 200-2520-00 **$5.50**

**Accessory Pouch*1** — Order 016-0677-02 **$42**

**Viewing Hoods** —
(Collapsible) Order 016-0592-00 **$13**
(Binocular) Order 016-0566-00*1 **$18.50**
(Polarized) Order 016-0180-00 **$40**

**Carrying Strap** — Order 346-0199-00 **$17**

**Carrying Case** — Order 016-0792-00*2 **$340**

**Rack Adaptor Kits** —
(2235) Order 016-0466-00 **$110**
(2235 Option 01) Order 016-0833-00 **$150**
(2236) Order 016-0015-00 **$230**

**CRT Light Filter** —
(Clear*1) Order 337-2775-01 **$1.75**
(Blue) Order 337-2775-00 **$3.00**

**1107 Mounting Kit** — Order 016-0785-00 **$50**

**1107 DC Inverter** — See page 281. **$475**

**1106 Battery Pack** — See page 281. **$1,235**

**1105 Power Supply** — See page 281. **$1,650**

**A6902B Isolator** — See page 437.

**A6901 Ground Isolator Monitor** — See page 438. Order A6901 **$650**

#### RECOMMENDED PROBES

See probe section for additional probes, page 425.

**P6420 DMM RF Probe** — Order 010-6420-03 **$145**

**40 kV DMM Probe** — Order 010-0277-00 **$165**

**P6602 Temperature Probe** — For use with 2236 CTM. Order 010-6602-00 **$225**

#### RECOMMENDED CAMERAS

**C-5C** — See page 413.
(2235 Option 01) C-5C Option 02 **$465**
(2235, 2236) C-5C Option 04 **$495**

**C-7** — See page 416.
(2235, 2236) C-7 Option 02 **$595**
(2235 Option 01) Option 03 **$565**

**C-4** — (2235 Option 01) See page 414. **$370**

#### RECOMMENDED CARTS

**K212** — (On-site mobility) See page 423. **$330**

**K117** — (Site-to-site mobility) See page 423. **$265**

#### SERVICE MANUALS

(2235) Order 070-4206-00 **$25**
(2236) Order 070-4204-00 **$25**

**1 Standard with the 2235 Option 01 (AN/USM-488).*
**2 Recommend use with front panel cover (200-2520-00).*





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

# MILITARY AND SPECIAL SERVICE OSCILLOSCOPES

## 2235 Option 01
**(AN/USM-488)**

**Dc to 100 MHz Bandwidth**

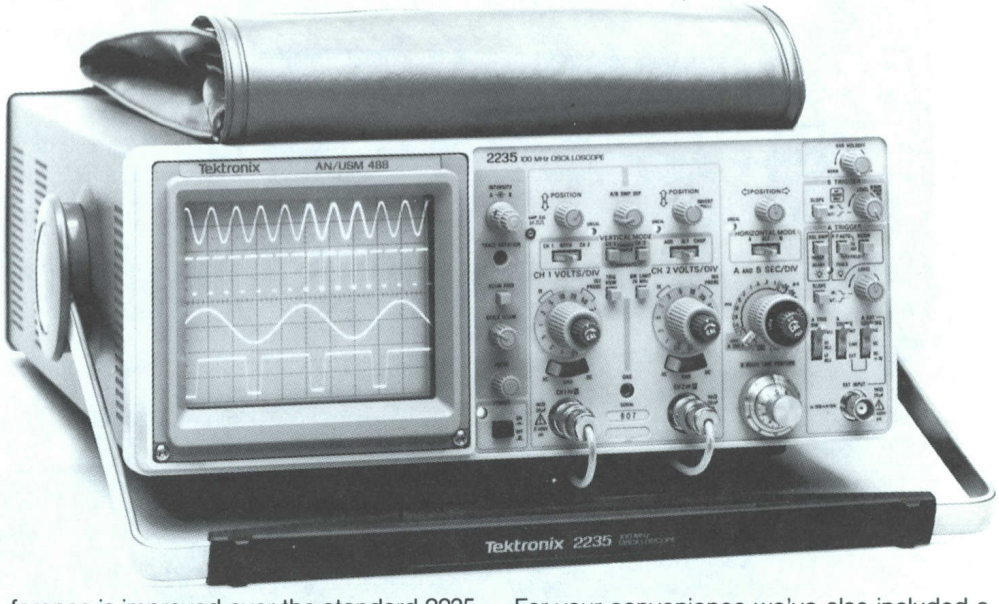
**Fully Provisioned Through the U.S. Army System**

**Meets or Exceeds MIL-T-28800C and MIL-STD-461B Part 4 for EMC/EMI**

**Three Year Warranty—Five Year Option**

**Accepted and Specified by the U.S. Army**

**National Stock Number 6625-01-187-7847**




The 2235 Option 01 is accepted and specified by the U.S. Army. If you're involved in designing and specifying systems for the U.S. Army, here is a 100 MHz oscilloscope that should top your support equipment lists.

Comparable in performance to the standard 2235, the 2235 Option 01 version has impressive features. It meets the rigid environmental requirements of MIL-T-28800C for Class 5 instruments. Electromagnetic interference is improved over the standard 2235, and meets MIL-STD-461B part 4 requirements. It has adjustable graticule illumination as well as uncalibrated indicator lights for both the horizontal time base and the vertical channels. HF REJ and LF REJ filtering expand flexibility for trigger coupling.

For your convenience we've also included a protective front-panel cover, cord wrap/storage pouch, binocular viewing hood, P6101A 1X 2-meter probe, BNC T connector, BNC male-to-binding post, two IC grabber tips and a service manual.

For a complete description see page 274.

## 2336YA

**Dc to 100 MHz Bandwidth**

**5 mV/div to 5 V/div**

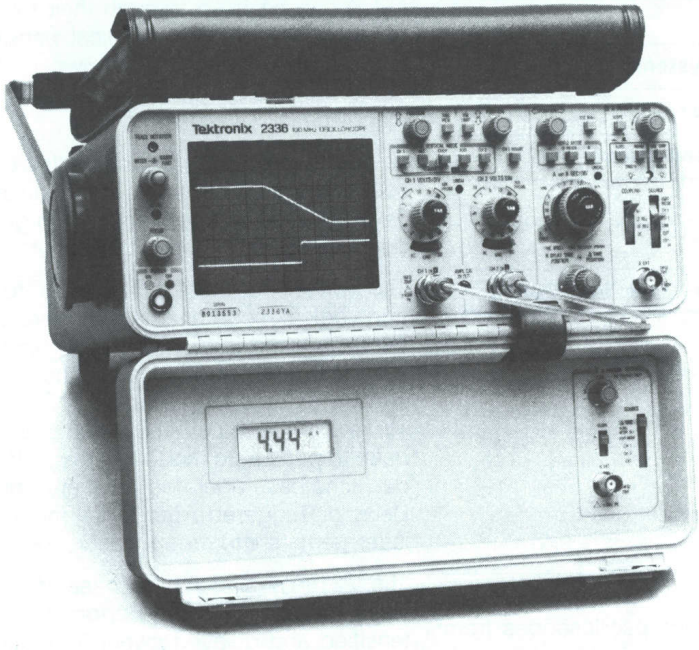
**5 ns/div Sweep Rate**

**Rugged for Field Service**

**Three Year Warranty—Five Year Option**

**Accepted and Specified by the U.S. Navy**

**National Stock Number 6625-01-172-6119**



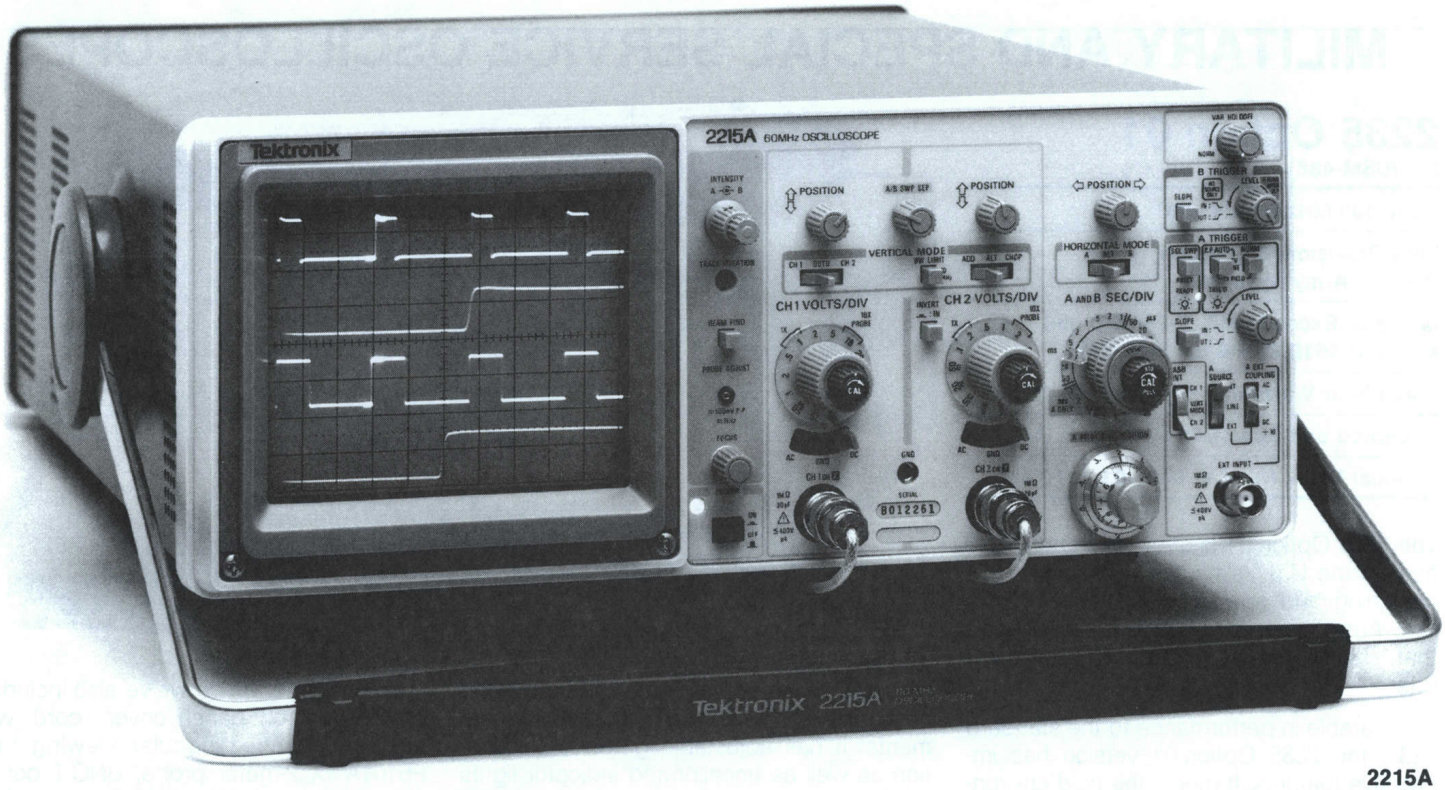

Compact and lightweight for ultra-portability, designed and built for on-site troubleshooting. The 2336YA is useful for high speed logic and digital applications and features an innovative and protective flip-top cover that doubles as a front panel indicator for ΔTime measurements. The entire outside case is made of durable, one-piece aluminum and the front panels are coated with scratch resistant plastic. When the flip-top is latched shut, the entire scope can withstand the abuse and heavy usage of field service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div.

The 2336YA comes with detachable power cord, integral EMI shielding, and an accessories pouch. It is manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. This ruggedness meets MIL-T-28800, Class 3 environmental requirements for aerospace and military qualification.

The 2336YA has a 5000 hour elapsed time indicator installed, and also includes additional accessories and an extra set of manuals.

For a complete description see page 268.




2215A

# 2215A/2213A

- Dc to 60 MHz Bandwidth
- Lightweight
- Easy to Use
- 2 mV Sensitivity
- Advanced Trigger System
- 5 ns/div Sweep Rate
- Delayed Sweep Measurements
- Large, Bright CRT
- 10X Probes Included
- Three Year Warranty—Five Year Option

## TYPICAL APPLICATIONS

* Television Service
* Production Test
* Education

Two 60 MHz, dual trace oscilloscopes from Tektronix offer unprecedented value in both initial and life cycle costs. Beginning with the architecture developed for the 2235, the improvements found in that instrument have been incorporated into the 2213A and 2215A. This approach leads to improved specifications, even higher reliability and new features such as bandwidth limit, single sweep, and a bright 14 kV dome mesh CRT.

These oscilloscopes provide unexcelled performance in a small lightweight package; 6.1 kg (13.5 lb) 2215A; 5.8 kg (12.8 lb) 2213A.

X-Y operation is simple and easy to use. Both vertical input channels (CH 1 and CH 2) can be used through their full range of sensitivity settings. Vertical sensitivities range from 2 mV to 5 V/div. Sweep speeds range from 0.5 s/div to 50 ns/div. A 10X magnification provides 5 ns/div.

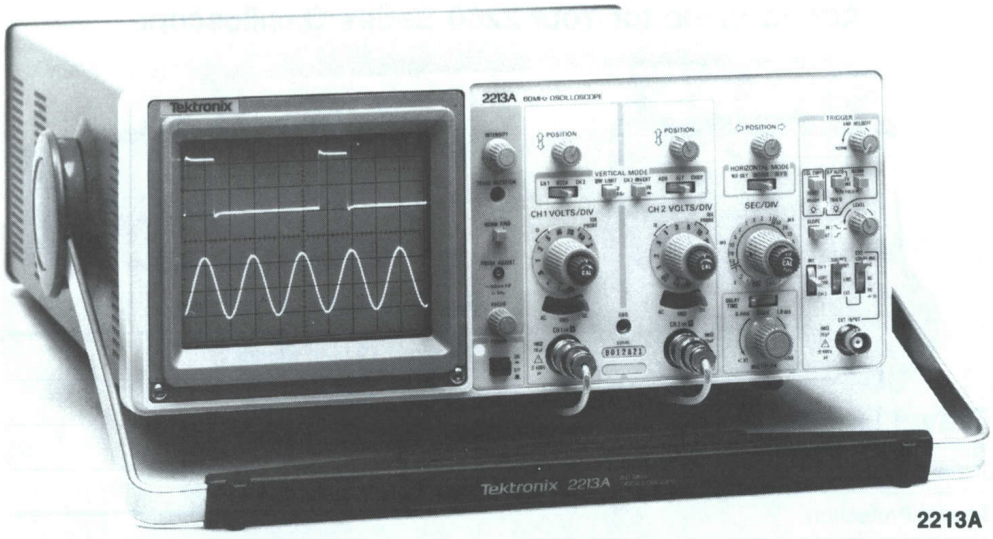
A pushbutton beamfinder allows easy scope setups. The scope bezel accepts a Tektronix C-5C scope camera with graticule illuminating flash (Option 04).

The advanced triggering system features true vertical mode alternate triggering; both the 2215A and 2213A will trigger alternately even with unrelated signals. Other features include variable trigger holdoff, TV line and TV field triggering at any sweep speed, and peak to peak auto mode. On the 2215A, the dual time base operates in either Runs After Delay or Triggered After Delay modes. The latter permits jitter-free measurements.

The 2213A's single time base delay provides the user with the performance of intensified and delayed sweep operations at a low price. Where dual time base performance is required, the 2215A delivers it with alternate sweep switching. The 2215A can display four traces; vertical channels 1 and 2 at the A sweep rate, and vertical channels 1 and 2, delayed, at the B sweep rate. The 2215A also has separate A and B intensity controls that provide convenient control over the A sweep, intensified zone, and B sweep.

Low life cycle cost is brought about by the inherent reliability of the new scopes. The parts count and cabling have been greatly reduced as compared to older designs. Even the traditional line transformer and line voltage selector switches have been eliminated, thanks to a new high-efficiency power supply. The advantages of these power supply improvements are that the 2215A and 2213A will operate from mains voltages of 90 V to 250 V RMS at frequencies from 48 Hz to 440 Hz. Additional reliability also results from superior mechanical design and packaging, soldered-in components, absolute minimum of connectors and very low power consumption.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers a three year warranty. All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.




2213A

## CHARACTERISTICS

The following electrical characteristics are common to the 2215A and 2213A except where noted:

### VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

**Bandwidth (−3dB) and Risetime**

| 0°C to +35°C | 0°C to +50°C |
|---|---|
| Dc to 60 MHz, 5.8 ns<br>5 mV/div to 5 V/div | Dc to 50 MHz, 7 ns<br>5 mV/div to 5 V/div |
| Dc to 50 MHz, 7 ns<br>2 mV/div | Dc to 50 MHz, 7 ns<br>2 mV/div to 5 V/div |

**Bandwidth Limit** — 10 MHz ±15%.

**Deflection Factor** — 2 mV/div to 5 V/div ±3% (0°C to +50°C). 1-2-5 sequence. Uncalibrated: Continuously variable between steps to at least 12.5 V/div.

**Display Modes** — CH 1, CH 2, Add CH 2 Invert, Alternate, Chopped, (≈500 kHz).

**Common-Mode Rejection Ratio** — At least 10:1 at 25 MHz for common-mode signals of 6 divisions or less.

**Input R and C** — 1 MΩ ±2% paralleled by 20 pF ±2 pF.

**Maximum Input Voltage (Ac and Dc Coupled)** — 400 V (dc + peak ac) or 800 V (p-p to 10 kHz).

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL SYSTEM

**Time Base A (2215A and 2213A)** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). 10X magnifier extends max sweep rate to 5 ns/div.

**Time Base B (2215A Only)** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). 10X magnifier extends max sweep rate to 5 ns/div.

**Variable Time Control (2215A and 2213A)** — Time Base A provides continuously variable uncalibrated sweep rates between steps to at least 1.25 s/div.

**Time Base A (2215A and 2213A) and B (2215A Only) Accuracy**

| | +15°C to +35°C | 0°C to +50°C |
|---|---|---|
| Unmagnified | ±3% | ±4% |
| Magnified | ±4% | ±5% |

**Display Modes** — 2213A: A, A intensified after delay, delayed. 2215A: A, alternate (A Intensified and B Delayed), and B.

### CALIBRATED SWEEP DELAY (2215A)

**Delay Time Range** — Continuously variable with 10-turn control from <0.5 +300 ns to >10 div.

**Differential Delay Time Measurement Accuracy** — ±1.0% (+15°C to +35°C) or ±2.0% (0°C to +50°C).

**A/B Sweep Separation** — Control permits main and delayed sweep to be separated ±3.5 div.

**Jitter** — 20,000 to 1 (0.005%) of maximum available delay time.

### SWEEP DELAY (2213A)

**Delay Time Range** — 1.0 μs, 20 μs, and 0.4 ms.

**Multiplier** — Increases delay time by 50 to 1 or more.

**Jitter** — 10,000 to 1 (0.01%) of maximum available delay time.

### TRIGGERING

**Trigger Modes** — Normal, Peak-to-Peak Automatic, and TV Field, TV Line, and Single Sweep.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms.

**A Trigger Sensitivity —**

| 2215A and 2213A | Internal | External (p-p volts) |
|---|---|---|
| 5 MHz | 0.3 div | 40 mV |
| 60 MHz | 1.0 div | 150 mV |

**TV Trigger Sensitivity** — TV Field: 1.0 div, TV Line: 0.3 div of composite sync.

**Bandwidth Limiting** — 10 MHz when BW limit switch depressed.

**External Inputs** — R and C 1 MΩ paralleled by 20 pF. 400 V (dc + peak ac) or 800 V ac p-p at 10 kHz or less.

### DELAYED (B) TIME BASE (2215A)

**Level and Slope** — Separate slope and level controls for triggering B sweep.

**B Trigger Sensitivity** — 0.4 div at 5 MHz. 1.5 div at 60 MHz (internal source only).

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 X, CH 2 Y)** — 2 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 2 MHz. Phase difference between X and Y is 3° or less from dc to 100 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 cm display. Horizontal and vertical center lines further marked in 0.2 cm increments, mesh grid. Accelerating potential is 14 kV. GH (P31) phosphor standard.

**Graticule** — Internal, nonparallax, unilluminated.

**Beam Finder** — Compresses trace to within graticule area for ease in locating an off-screen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation; dc to 10 MHz.

### OTHER CHARACTERISTICS

**Probe Adjust Signal** — Squarewave, 0.5 V ±5%, 1 kHz ±20%.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 40 W, 70 V A.

**Dc Operation** — 12 V to 30 V available with 1105, 1106, and 1107.

### ENVIRONMENTAL

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the major axes. 0.015 in p-p displacement 10 Hz to 55 Hz to 10 Hz in one minute cycles. Held for 10 minutes at 55 Hz (2.4 g's at 55 Hz).

**Humidity** — Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800C, par 4.5.5.1.2.2.

**Shock** — Operating: 30 g's ½ sine, 11 ms duration, 3 shocks per axis along each major axis. Total of 18 shocks.

**EMC** — Meets Class B requirements per VDE 0871B for radiated and conducted emission.

### PHYSICAL CHARACTERISTICS

| | 2215A | | 2213A | |
|---|---|---|---|---|
| Dimension | mm | in | mm | in |
| Width*1 | 328 | 12.9 | 328 | 12.9 |
| Height | 137 | 5.4 | 137 | 5.4 |
| Depth*2 | 440 | 17.3 | 440 | 17.3 |
| **Weights≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 6.1 | 13.5 | 5.8 | 12.8 |

*1 *Without handle.*
*2 *Without front cover.*

**See Ordering Information on next page.**

## ORDERING INFORMATION

**2215A** Delayed Alternate Time Base Oscilloscope **$1,525**

**Includes:** Two P6122 10X voltage probes (010-6122-01); operator manual (070-4732-00).

**2213A** Single Time Base Oscilloscope with Delayed Sweep **$1,275**

**Includes:** Two P6122 10X voltage probes (010-6122-01); operator manual (070-4734-00).

**Impact resistant packaging** — Contact your local Tektronix sales engineer for details.

**Power Cords** — Standard: 110 V ac North American plug.

### OPTIONS

**Option 02** — Front panel cover and accessory pouch. **+$47**

**Option 33** — Travel Line Package. **$200**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz. Order 020-0859-00.

**Option A2** — UK 240 V/13 A, 50 Hz. Order 020-0860-00.

**Option A3** — Australian 240 V/10 A, 50 Hz. Order 020-0861-00.

**Option A4** — North American 240 V/15 A, 60 Hz. Order 020-0862-00.

**Option A5** — Switzerland 220 V/10 A, 50 Hz. Order 020-0863-00.

### *WARRANTY-PLUS* SERVICE PLANS— SEE PAGE 457

**M1** — (2213A) 2 Calibrations. **+$85**
**M1** — (2215A) 2 Calibrations. **+$100**
**M2** — (2213A) +2 Years Service. **+$100**
**M2** — (2215A) +2 Years Service. **+$110**
**M3** — (2213A) 2 Years Service & 4 Calibrations. **+$265**
**M3** — (2215A) 2 Years Service & 4 Calibrations. **+$290**
**M4** — (2213A) 5 Calibrations. **+$270**
**M4** — (2215A) 5 Calibrations. **+$295**
**M5** — (2213A) 9 Calibrations +2 Years Service. **+$585**
**M5** — (2215A) 9 Calibrations +2 Years Service. **+$620**

## OPTIONAL ACCESSORIES

**Travel Line Package Retrofit Kit** — See this page.
**Rack Adaptor Kit** — Order 016-0466-00 **$110**
**Front Panel Cover** — Order 200-2520-00 **$5.50**
**Accessory Pouch** — Order 016-0677-02 **$42**
**Pouch and Cover** — Order 020-0672-02 **$47**
**Viewing Hoods** —
(Collapsible) Order 016-0592-00 **$13**
(Binocular) Order 016-0566-00 **$18.50**
(Polarized) Order 016-0180-00 **$40**
**Carrying Strap** — Order 346-0199-00 **$17**
**Carrying Case** — Order 016-0792-00 **$340**
**CRT Light Filter** —
Clear. Order 337-2775-01 **$3.00**
**A6902B Isolator** — For floating measurements see page 437 for complete description.

### RECOMMENDED PROBES

See pages 255 and 425.

### RECOMMENDED CAMERAS

**C-5C Option 04** — See page 415. **$495**
**C-7 Option 02** — See page 410. **$595**

### RECOMMENDED CARTS

**K212** — For on-site mobility. See page 423. **$330**
**K117** — For site-to-site mobility. See page 423. **$265**

### SERVICE MANUALS

**(2213A)** — Order 070-4733-00 **$25**
**(2215A)** — Order 070-4735-00 **$25**

## Added Value for Your 2200 Series Oscilloscope

## Travel Line Package

**Impact Resistant Packaging**

**Impact Protection**

**Cord Wrap**

**Pouch and Cover**

**Carrying Strap**

Now, give your 2200 Series instrument the added protection often necessary when used in rough environments. This package provides protection from impacts along the front and rear of the instrument. The rear bumper is designed to provide a wider base to set the instrument on and reduces the potential of tip over when standing vertically. The rear also has integrated in it a power cord wrap.

The high quality rubber moldings offer long life and are resistant to cracking and becoming brittle with age. This composition provides excellent desk/bench and inclined plane grab, so there is no worry about instrument slippage.

A front panel protective cover and an accessory pouch for carrying probes and documentation is also included, plus a convenient carrying strap for hands free operation and transport.

The Travel Line Package is available for 2200 Series products. It can be ordered at the time of purchase or as a field retrofit kit.

### ORDERING INFORMATION

**Travel Line Package** — Includes rubber moldings, accessory pouch, front panel cover, and carry strap. Order your 2200 Series instrument with Option 33. **$200**

**Travel Line Package Conversion Kit** — Includes same items as in the Option 33 Travel Line Package including replacement cabinet and rear cover with the rubber moldings installed.
(2213, 2215, 2213A, 2215A, and 2235) Order 040-1188-00 **$250**
(2236) Order 040-1187-00 **$250**
ontact your local sales engineer or the National Marketing Center. **$250**

## Rackmount Adapter

**Standard 19 Inch Mount**

**Rack Depth Extenders**

**Easy Assembly**

**Rack Height Only 5.14 Inches**

The low-cost rack adapter provides the means to rackmount the high-performance high-value 2200 Series oscilloscope family. The rackmount is very space efficient, requiring only 5.14 inches of rack height. Rack extenders are provided to allow mounting to virtually any depth rack main frame. A mounting hole is provided for a BNC connector to route the Z-axis input to the front face of the rack. All hardware is supplied for complete mounting into your mainframe.

Kits are available for all 2200 Series products. It can be ordered at any time and is customer installable. For the *NEW* 2220 and 2230 Digital Storage Oscilloscopes the kit also provides access for the optional GPIB or RS-232C interface connections for automated systems.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Mount Width | 464 | 18.3 |
| Height | 131 | 5.1 |
| Depth*1 | 458 | 18.1 |
| **Weights** | **kg** | **lb** |
| Net (Kit) | 1.5 | 3.2 |
| Net (Additional to instrument mount) | .7 | 1.6 |

*1 *Does not include extenders.*

### ORDERING INFORMATION

**Rackmount Adaptor Kit** — Includes rackmount depth extenders, all mounting hardware, labels, and instruction manual. 2236 kit also includes DMM connector.
(2215, 2213, 2215A, 2213A, 2235) Order 016-0466-00. **$110**
(2235 Opt 01) Order 016-0833-00. **$150**
(2236) Order 016-0015-00. **$230**
(2220/2230) Order 016-1003-00.

### OPTIONAL ACCESSORIES

**BNC Female to BNC Female Connector** — Order 103-0070-00 **$6.00**
**50 Ω RF Coaxial Cable** — Order 012-0117-00 **$17.00**



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

*Shown (from left) are the 1105 Power Supply, the 1106 Battery Pack, and the 1107 Dc Inverter.*

## Portable Power

Tektronix power accessories offer true field-use-portability and operating freedom at service and maintenance sites where conventional ac power sources are not available. They let your scopes go where you need them—and have enough power for your testing and troubleshooting tasks.

The following table outlines the preferred power accessory (or accessory combination) for Tektronix portable oscilloscopes. Note that for many instruments, the 1105 Power Supply is a compatible alternate dc power source.

| Instrument | Recommended Power Accessory |
|---|---|
| 2213*2, 2213A*1, 2215*2, 2215A*1, 2220*1, 2230*1, 2235 Option 01*1, 2235*1, 2236*1, 2335*1, 2236*1, 2336YA*1, 2337*1, 2445*1, 2465*1, 2465CTS, 4265DVS, 2465DMS | 1107/1106 Inverter Battery Pack Combination or 1107 Dc Inverter with Auxiliary Dc Source |
| 314, 335, 464*3, 465B*3 466*3, 475*3, 475A*3 | 1106 Battery Pack or 1105 Power Supply |
| 336, 434, 465M, 468*4, 485 | 1105 Power Supply |

**1 The 1105 Power Supply is also compatible with these instruments.*

**2 Some lower-serial-numbered units are not compatible for use with the 1107 Dc Inverter and the 1105 Power Supply. Neither the 1107 Dc Inverter nor the the 1105 Power Supply are compatible with the following instruments, unless Option 48 is installed:*

*US-built 2213 below Serial Number B020100*
*US-built 2215 below Serial Number B022000*
*UK-built 2213 below Serial Number 200239*
*UK-built 2215 below Serial Number 200307*

**3 These instruments require Option 07 for operation with the 1106 Battery Pack. Field conversion kits are available. Contact your local Tektronix sales engineer. But when the 1105 Power Supply is used with these 400 Series instruments, Option 07 is not required.*

**4 Because of limited instrument operating time available when running from the internal batteries, it is recommended that an external dc power source be used.*

## 1105 Power Supply

### CHARACTERISTICS

#### ELECTRICAL

**Internal Battery Voltage Range** — +22 V to +28 V.

**External Dc Input Voltage Range** — +24 V to +30 V. Maximum elevation for the positive and the negative power leads is 60 V with respect to chassis ground.

**Output** — Waveform: Squarewave. Frequency: 60 Hz ±10%. Amplitude: See following table.

| Dc Power Source | Peak Ac Output | |
|---|---|---|
| | Standard Configuration and 0.9-A Load | Option 01 Configuration and 0.45-A Load |
| +22 V Internal<br>+24 V External | 108 V ±7% | 216 V ±7% |
| +28 V Internal<br>+30 V External | 138 V ±7% | 276 V ±7% |

**Maximum Recommended Output Current** — Standard: 0.9 A. Option 01: 0.45 A.

**Minimum Battery Operating Time** — 50 watt hours from full charge.

**Battery Charging Time** — 14 hours to 16 hours from full discharge at temperatures from 0°C to +40°C (+32°F to +104°F).

**Battery Charging Rate** — Full: 600 mA ±10%. With Thermal Cutout Open: 254 mA ±10%.

**Ac Charging Power Frequency Range** — 50 Hz to 60 Hz.

**Ac Charging Voltage Rates** — See following table.

| 1105 Line Voltage Selection Wiring | Ac Voltage Ranges | |
|---|---|---|
| | Standard Configuration | Option 01 Configuration |
| From Factory | 100 V to 132 V | 200 V to 264 V |
| With Internal Connection Changes | 90 V to 120 V<br>180 V to 240 V<br>200 V to 264 V | 90 V to 120 V<br>100 V to 132 V<br>180 V to 240 V |

**Maximum Power Consumption from Ac Source** — 40 W.

#### ENVIRONMENTAL

**Ambient Temperature** — Operating: 0°C to +40°C (+32°F to +104°F). Nonoperating (with battery installed): −40°C to +60°C (−40°F to +140°F). Nonoperating (without battery): −55°C to +75°C (−67°F to + 167°F).

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 165 | 6.5 |
| Height | 250 | 9.8 |
| Depth | 216 | 8.5 |
| **Weight** | **kg** | **lb** |
| Net | 8.8 | 19.4 |

### ORDERING INFORMATION

**1105 Power Supply** **$1,650**

**Includes:** Dc power cord, 915 mm (36 in), for external dc input (161-0094-00); instruction manual (070-1479-01).

**Option 01** — 230 V Operation. **NC**

**Includes:** 2.1 m (7 ft) IEC power cable (161-0098-00).

## 1106 Battery Pack

### CHARACTERISTICS

#### ELECTRICAL

**Dc Power Output** — +22 V to +24 V for 7 ampere-hour with maximum current of 5 A.

**Minimum Battery Operating Time** — 75 watt hours from full charge.

**Battery Charging Time** — 14 hours to 16 hours, from full discharge, at temperatures from 0°C to +40°C (+32°F to +104°F).

**Battery Charging Rate** — Full: 620 mA. With Thermal Cutout Open: 60 mA.

**Ac Charging Power Frequency Range** — 50 Hz to 400 Hz.

**Ac Charging Voltage Ranges** — Standard: 100 V to 132 V; 200 V to 264 V. With Internal connection change: 90 V to 120 V; 180 V to 240 V.

**Maximum Ac Charging Power Consumption** — 40 W at 115 V, 60 Hz.

#### ENVIRONMENTAL

**Ambient Temperature** — Operating: 0°C to +40°C (+32°F to +104°F) Nonoperating (with battery installed): −40°C to +60°C (−40°F to +140°F). Nonoperating (without battery): −55°C to +75°C (−67°F to +167°F).

#### PHYSICAL CHARACTERISTICS

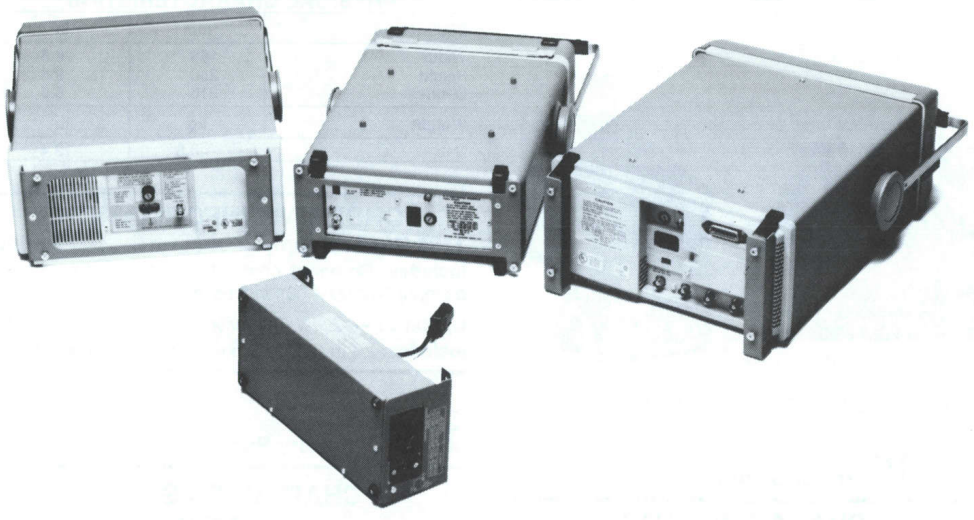
| Dimensions | mm | in |
|---|---|---|
| Width (latches in latched position) | 292 | 11.5 |
| Height (w/feet & latches) | 66 | 2.6 |
| Depth | 432 | 17.0 |
| **Weight** | **kg** | **lb** |
| Net | 7.3 | 16.0 |

### ORDERING INFORMATION

**1106 Battery Pack** **$1,235**

**Includes:** Instruction manual (070-1713-00).

**Mounting Kit for 2445 and 2465 Oscilloscopes** — Order 016-0797-00. **$50**



*The 1107 Dc Inverter can be quickly attached to or detached from the rear of Tektronix 2000 Family oscilloscopes via easily installed adapter kits. Shown here with adapters installed are (from left) the Tektronix 2236, 2336 and 2465 Oscilloscopes.*

*The Tektronix 2465 Oscilloscope with attached 1106 Battery Pack and 1107 Dc Inverter becomes a completely independent measurement package—readily transportable to remote sites where conventional ac power sources are not available.*

## 1107 Dc Inverter

### CHARACTERISTICS

#### ELECTRICAL

**Output Frequency** — Approximately 60 Hz.

**Output Voltage and Timing (+12 V Mode)** — Measured with a 200 Ω resistive load (approximately 60 W).

| Output Parameter | Output | |
|---|---|---|
| | With +12.3 V Dc Input | With +14.2 V Dc Input |
| Peak Voltage | 160 V ±10% | 160 V ±10% |
| Table Voltage | 130 V ±10% | 140 V ±10% |
| Turn-on Time | 6.2 ms ±15% | 6.2 ms ±15% |
| Dead Time | 2.2 ms ±15% | 2.2 ms ±15% |

**Output Voltage and Timing (+24 V Mode)** — Measured with a 166 Ω resistive load (approximately 100 W).

| Output Parameter | Output | |
|---|---|---|
| | With +22.5 V Dc Input | With +28.5 V Dc Input |
| Peak Voltage | 150 V ±10% | 160 V ±10% |
| Table Voltage | 135 V ±10% | 150 V ±10% |
| Turn-on Time | 6.2 ms ±15% | 6.2 ms ±15% |
| Dead Time | 2.2 ms ±15% | 2.2 ms ±15% |

**Rated Output Power in +12 V Mode** — 70 W (−15°C to +35°C); 50 W (−15°C to +55°C). Dc source must be 117 VA a +11.7 V or greater.

**Rated Output Power in +24 V Mode** — 100 W.

**Output Overload Protection** — Ouput is disabled and audible tone generated when the ac load exceeds 100 W.

**Input Voltage Range Selection** — Selection between +12 V mode and +24 V mode is automatic.

**Operating Inputs** — Measured at input of supplied dc power cord.

| | Dc Volts | |
|---|---|---|
| | +12 V Mode | +24 V Mode |
| Turn-on Range | +11.7 to 15.9 ±5% | +22.2 to +30.0 ±5% |
| Battery Protection Shut-down Limit*[1] | +10.0 ±5% | +21.0 ±5% |
| Difference Between Minimum Turn-on Range and Battery Protection Shut-down Limit*[1] | ⩾1.2 | ⩾0.85 |

*[1] *Tested with a variable dc supply without a load on the output.*

#### ENVIRONMENTAL

The 1107 Dc Inverter meets environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment with humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.9.2.3, and 3.9.2.4, except Electromagnetic Compatiblity.

**Ambient Temperature** — Operating: −15°C to +55°C (+5°F to +131°F). Nonoperating: −62°C to +85°C (−80°F to +185°F).

**Altitude** — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 300 m (1,000 ft) above 1500 m (5,000 ft). Nonoperating: To 15,250 m (50,000 ft).

**Humidity** — Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C par 4.5.5.1.2.2. for Type III, Class 3 Instruments.

**Electromagnetic Compatibility** — Meets radiated emission requirements per VDE 0871 Class B, Meets MIL-STD-461B for the following tests: Part 4 (CE01, CE03, and CS02); Part 5 (CS06 and RS02); and Part 7 (CS01, RE02, and RS03). Conducted emissions measurements are performed on the dc input power cord.

**Vibration** — Operating: 15 minutes along each of three major axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute sweeps. Held 10 minutes at 55 Hz in each of the three major axes.

**Shock** — Operating and Nonoperating: 50 g, ½ sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks.

**Note:** The following 1107 Dc Inverter and oscilloscope combinations meet or exceed MIL-T-28800C Class 3 requirements for vibration and shock when attached together in a unitized package with designated mounting hardware:

1107/2445
1107/2465
1107/1106/2445
1107/1106/2465
1107/2335
1107/2336
1107/2337

**Transportation Package Vibration** — Meets the limits of National Safe Transit Association Test Procedure 1A-B-1.

**Transportation Package Drop** — Meets the limits of National Safe Transit Association Test Procedure 1A-B-2 with a 914 mm (36 inch) drop.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 276 | 10.9 |
| Height | 119 | 4.7 |
| Depth | 84 | 3.3 |
| **Weight** | **kg** | **lb** |
| Net | 1.6 | 3.5 |
| Shipping | 1.8 | 4.0 |

### ORDERING INFORMATION

**1107 Dc Inverter** **$475**

**Includes:** 559 mm (22 in), dc power cord (161-0095-00); instruction manual (070-5056-00).

### OPTIONAL ACCESSORIES

**1107 Mounting Kit for 2445 and 2465 Oscilloscopes** — Order 016-0783-00 **$50**

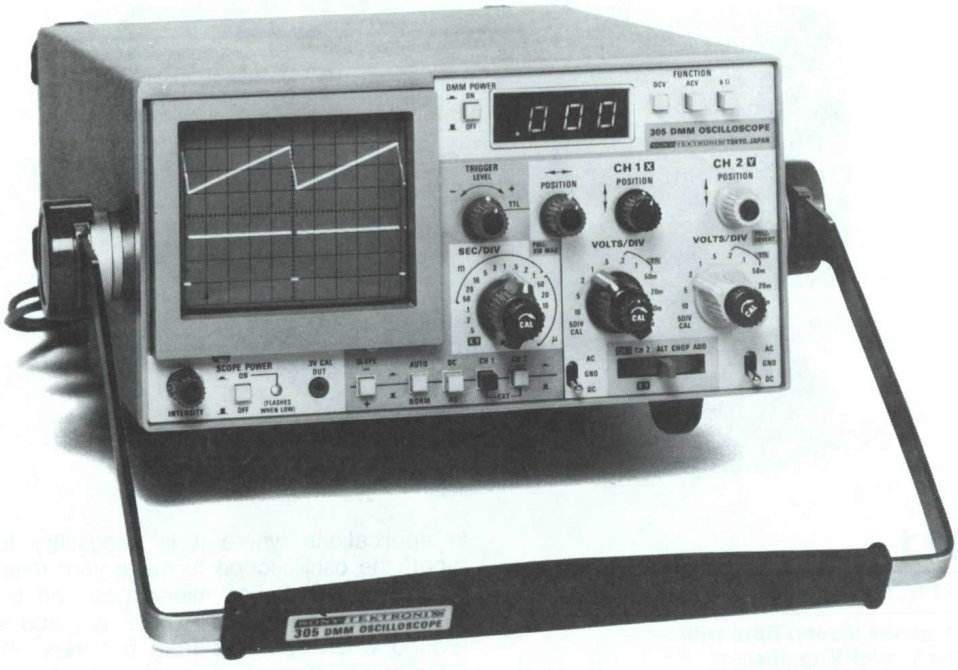
**1107 Mounting Kit for 2335, 2336, 2336YA and 2337 Oscilloscopes** — Order 016-0786-00 **$50**

**1107 Mounting Kit for 2200 Series Oscilloscopes** — Order 016-0785-00 **$50**

**1106 Mounting Kit for 2445 and 2465 Oscilloscopes** — Order 016-0797-00 **$50**



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99




# 305

**5 MHz at 5 mV/div** — **Full X-Y**

**Dual Trace/DMM** — **Weighs ≈10.6 lb**

**Internal Battery Pack**

## TYPICAL APPLICATIONS

* **Electro-Mechanical Measurements**
* **Medical Electronics Maintenance**
* **Automotive/Motor Vehicle**

The 305 Oscilloscope/DMM is the ideal oscilloscope for those who demand portability and multifunction versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5 MHz oscilloscope with a precise integral autoranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5 MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Bandwidth** — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is ≈10 Hz.

**Deflection Factor** — 5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.

**Display Modes** — CH 1, CH 2, Chopped, Alternate, Added, Invert CH 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.

**Input R & C** — 1 MΩ ±2%, paralleled by ≈47 pF.

**Maximum Input Voltage** — Ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p at <1 kHz.

### HORIZONTAL SYSTEM

**Time Base** — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 magnifier extends sweep rate to 0.1 μs/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

**Time Base Accuracy*1**

| | 0°C to +40°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±3% | ±4% |
| Magnified | ±5% | ±6% |

*1 *Center 8 divisions (excludes first 10 divisions and all sweep past 90 divisions in X10 magnifier).*

### TRIGGERING

**Modes** — Normal and Auto (p-p).

**TTL Triggering** — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V and 0.2 V/div or external trigger signals.

**Trigger Sources** — Internal CH 1, internal CH 2, external. TTL Threshold voltage, internal (with 10X probe) 1.4 V within ±0.3 V, External (with 10X probe) 1.4 V within ±0.2 V.

**Trigger Sensitivity in Normal Mode**

| Coupling | To 0.5 MHz | At 5 MHz |
|---|---|---|
| Dc Internal | 0.3 div | 0.75 div |
| Dc External | 15 mV | 50 mV |
| Ac | Requirements increase below 60 Hz | |

**P-P Auto Operation Sensitivity**

| Coupling | 500 Hz to 0.5 MHz | 0.5 MHz to 5 MHz |
|---|---|---|
| Dc, Ac Internal | 0.5 div | 1.0 div |
| Dc, Ac External | 35 mV | 70 mV |

**External Trigger** — Maximum Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C: ≈1 MΩ paralleled by ≈47 pF.

### X-Y OPERATION

**Input** — X-axis input is via the CH 1 connector; Y-axis input is via the CH 2 connector.

**X-Y Characteristics** — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.

**X-Axis Bandwidth** — Dc to 150 kHz.

### CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 div (0.632 cm/div) display. Accelerating potential is 2 kV. GH (P31) phosphor standard.

**Graticule** — Internal, nonilluminated.

### DMM

### DC VOLTAGE

**Ranges** — 2 V, 20 V, 200 V, 1000 V (autoranging).

**Accuracy** — Within 0.1% of reading, ±2 counts.

**Common-Mode Rejection** — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

**Normal-Mode Rejection** — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.

**Response** — <1 s plus range step time (<1 s/step).

**Input R** — 10 MΩ ±2%.

**Maximum Input Voltage** — ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

### AC VOLTAGE

**Ranges** — 2 V, 20 V, 200 V, 700 V, (autoranging).

**Accuracy** — Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.

**Response Time** — <5 s plus range step time (<1 s/step).

**Input Impedance** — 10 MΩ paralled by ≈70 pF.

**Maximum Input Voltage** — 700 V RMS if sinusoidal. ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs. ±500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

### RESISTANCE

**Ranges** — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.

**Accuracy** — Within 0.6% of reading ±3 counts.

**Response Time** — <5 s plus range step time (<1 s/step).

**Maximum Input Voltage** — ±100 V (dc + peak ac) between HI and LO inputs. 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.3 V accurate ±1% from 20°C to 30°C ±2% from −15°C to +55°C.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 132 V ac or 180 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 17 W.

**External Dc Source** — +9 V to +32 V.

**Charge Time** — At least 16 hours for full charge.

**Operating Time** — Internal NiCd batteries provide ≈1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or two hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

### ENVIRONMENTAL

**Ambient Temperature** — Operating: −15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM). Nonoperating: −25°C to +75°C.

**Altitude** — Operating: To 9000 m (30,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5,000 ft to 30,000 ft. Nonoperating: To 15 000 m (50,000 ft) maximum.

**Vibration** — 15 minutes along each of the 3 major axes, 0.025 in (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Nonoperating: 5 cycles (120 hours) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.

**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 236 | 9.3 |
| Height | 112 | 4.4 |
| Depth (handle not extended) | 371 | 14.6 |
| Depth (handled extended) | 458 | 18.0 |
| **Weights ≈** | **kg** | **lb** |
| Net (without accessories) | 4.8 | 10.6 |
| Shipping | 7.8 | 17.1 |

## ORDERING INFORMATION

**305** DMM/Oscilloscope **$2,590**

**Includes:** Two P6149 10X probes (010-6149-13); carrying case (016-0401-00); carrying case cover (200-2260-00); carrying strap assembly (346-0131-02); DMM probe package (012-0732-00); clear CRT filter (331-0394-01); blue CRT filter (378-2016-01); external dc cable assembly (012-0406-00); service manual (070-2423-01); operator manual (070-2424-00).

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan, Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### OPTIONAL ACCESSORIES

**Viewing Hood** — Order 016-0297-00 **$2.10**

**Adaptor Connector** — BNC to binding post. Order 103-0033-00 **$8.00**

### RECOMMENDED CAMERA

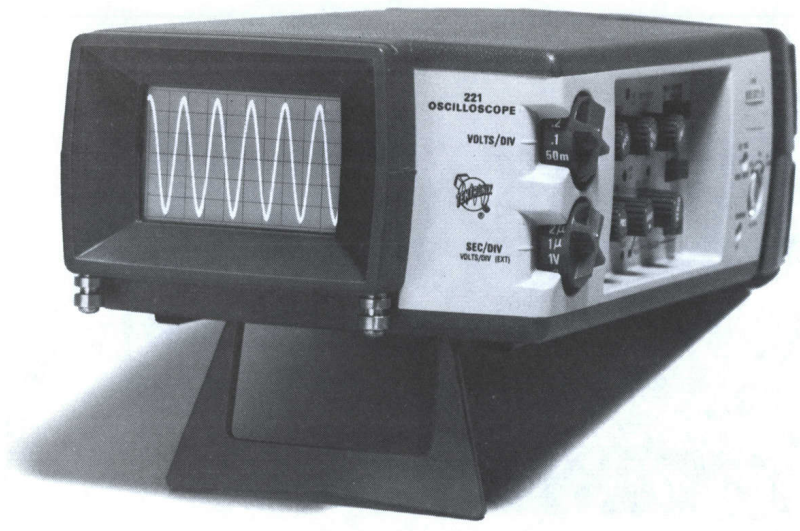
**C-30BP Option 01** — General purpose camera. See page 412. **$1524**

**Camera Adaptor** — Required to mount the C-30BP Camera to the 305. Order 016-0327-01 **$170**

### RECOMMENDED CARTS

**K212 Portable Instrument Cart** — For on-site mobility. See page 423. **$330**

**K117 Instrument Shuttle** — For site-to-site mobility. See page 423. **$265**




# 221

**5 MHz, 5 mV/div to 100 V/div**

**0.1 μs/div Sweep Rate with X10 Sweep Magnifier**

**Internal Battery Pack**

**Integral 1 MΩ Probe**

**Weighs ≈1.6 kg (3.5 lb)**

## TYPICAL APPLICATIONS

* **Communication Equipment Service**
* **Electro-Mechanical Measurements**
* **Industrial Plant Maintenance**

The 221 Miniscope weighs just 3.5 pounds and measures only 3 x 5.2 x 9 inches. It easily fits into a tool box or brief case, yet has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least two hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 V to 250 V, 48 Hz to 62 Hz ac, or 80 V to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Bandwidth (−3 dB point)** — Dc to 5 MHz at all calibrated deflection factors. Lower −3 dB point ac coupled is ≈2 Hz.

**Deflection Factor** — 5 mV/div to 100 V/div, accurate ±3% from 0°C to +40°C and ±5% from −15°C to 0°C and +40°C to +55°C. Uncalibrated; Continuously variable between steps to at least 300 V/div.

**Input R and C** — ≈1 MΩ paralleled by ≈29 pF via attached signal acquisition probe.

**Maximum Input Voltage** — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

### HORIZONTAL SYSTEM

**Time Base** — 1 μs/div to 200 ms/div, accurate ±3%.

**Magnifier** — Increases all sweep speeds X10 with a maximum sweep speed of 0.1 μs/div.

**Variable Time Control** — Extends minimum sweep rate to ≈0.5 s/div. Continuously variable between calibrated settings.

### TRIGGERING

**Modes** — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity**

| Source | To 1 MHz | At 5 MHz |
|---|---|---|
| Internal | 0.5 div | 1 div |
| External | 0.5 V | 1 V |





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

### X-Y OPERATION

**Input —** X-axis input is via the external trigger or the external horizontal input.

**X-Axis Deflection Factor —** 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

**Maximum External Horizontal Input Voltage —** 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

**Input Impedance —** ≈0.5 MΩ paralleled by ≈30 pF.

### CRT AND DISPLAY FEATURES

**CRT —** 6 x 10 div (0.52 cm/div) display. Accelerating potential is 1 kV. GH (P31) phosphor standard.

**Graticule —** Internal, black line, nonilluminated.

### OTHER CHARACTERISTICS

**Insulation Voltage —** 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line + (dc + peak ac) not to exceed 350 V.

**Power Sources —** Internal NiCd batteries provide at least 2 hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge.

### POWER REQUIREMENTS

**Line Voltage Range —** 90 V ac to 250 V ac or 80 V ac to 250 V ac.

**Line Frequency —** 48 Hz to 62 Hz.

**Maximum Power Consumption —** 5 W.

### ENVIRONMENTAL

**Ambient Temperature —** Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude —** Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration —** Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity —** 5 days at +50°C, 95% humidity.

**Shock —** Operating and Nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.2 |
| Height | 76 | 3.0 |
| Depth | 228 | 9.0 |
| **Weights ≈** | **kg** | **lb** |
| Net (w/o accesssories) | 1.6 | 3.5 |
| Shipping | 3.6 | 8.0 |

## ORDERING INFORMATION

**221** Oscilloscope **$2,260**

**Includes:** Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); two spare fuses (159-0080-00); service manual (070-1573-01); operator manual (070-1572-00).

### OPTIONAL ACCESSORIES

**Alligator Clip Kit —** A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ inch) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01). Order 015-0231-00 **$25**

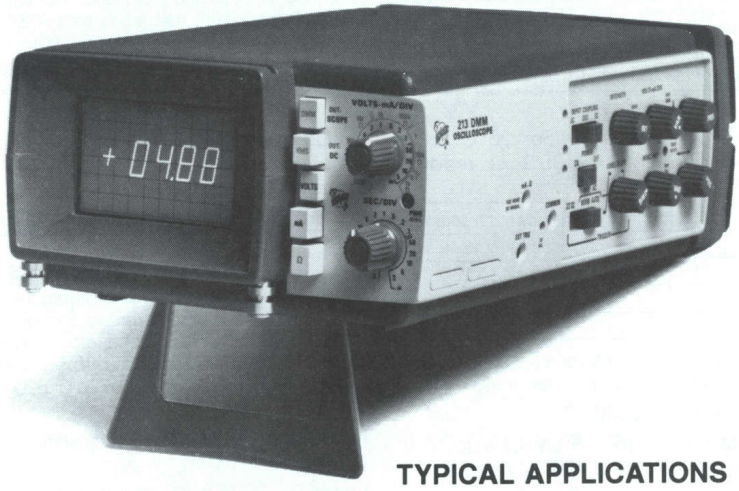
**Probe-Tip —** To BNC Panel Connector Adaptor. Order 013-0084-01 **$8.00**

**Probe-Tip —** To BNC Cable Adaptor. Order 103-0096-00 **$12.75**

**Power Cable Adaptor Assembly —** A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$6.00**

**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**






## 213

**1 MHz at 20 mV/div**

**0.4 μs/div Sweep Rate with X10 Sweep Magnifier**

**DMM and Miniscope in One Unit**

**Rugged Construction**

**Internal Battery Pack**

**Compact, Weighs ≈1.7 kg (3.7 lb)**

**True RMS Voltage & Current Measurements**

### TYPICAL APPLICATIONS

* **Power Equipment Measurements**
* **Medical Electronics Maintenance**
* **Industrial Control Systems**

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and light weight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the light weight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

# CHARACTERISTICS

## VERTICAL SYSTEM (VOLTAGE)

**Bandwidth** — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is ≈1 Hz.

**Deflection Factor** — 5 mV/div to 100 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 V/div.

**Input R and C** — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

**Maximum Input Voltage**

| Input Condition | Maximum Input Voltage |
|---|---|
| Dc coupled, 5 mV/div to 1 V/div | 500 V (dc + peak ac) at 1 MHz or less |
| Ac coupled, 5 mV/div to 1 V/div | 800 V (dc + peak ac) 500 V peak ac component |
| Ac, Dc coupled, 2 V/div to 100 V/div | 800 V (dc + peak ac) at 1 MHz or less |

## VERTICAL SYSTEM (CURRENT)

**Bandwidth** — Dc to at least 400 kHz (−3 dB point) for 20 μA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (−3 dB point) for 5 μA/div and 10 μA/div.

**Deflection Factor** — 5 μA/div to 100 mA/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps to at least 250 mA/div.

**Maximum Input Current** — 2 A RMS or 3 A peak for any range (fuse and diode protection).

## HORIZONTAL SYSTEM

**Time Base** — 2 μs/div to 500 ms/div (1-2-5 sequence). Accuracy: ±5%.

**Variable Magnifier** — Increases all sweep speeds to at least X5 with a maximum sweep speed of 0.4 μs/div.

## TRIGGERING

**Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).

**Trigger Sensitivity and Coupling** — Ac Internal: (Auto and Normal 1 MHz) 0.5 div. Dc External: 1 MHz, 1 V.

## CRT AND DISPLAY FEATURES

**CRT** — 6 x 10 div (0.52 cm/div) display. GY (P43) phosphor.

**Graticule** — Internal, black line, nonilluminated.

## OTHER CHARACTERISTICS

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS or 1.4X line + (dc + peak ac) not to exceed 350 V.

**Power Sources** — Internal NiCd batteries provide three to five hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires ≈16 hours.

## POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 136 V ac. Option 01 is 180 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 62 Hz.

**Maximum Power Consumption** — 8 W.

## ENVIRONMENTAL

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: To 7500 m (25,000 ft), decrease maximum temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 12 500 m (40,000 ft).

**Vibration** — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — +40°C or less, 80% or less relative humidity.

**Shock** — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.2 |
| Height | 76 | 3.0 |
| Depth | 226 | 8.9 |
| **Weights ≈** | **kg** | **lb** |
| Net (without accessories) | 1.7 | 3.7 |
| Shipping | 3.9 | 8.6 |

## DMM

Provides true RMS readings of voltage and current.

## DC AND AC VOLTAGE

**Range** — 0.1 V to 1000 V full scale in five ranges.

**Resolution** — 100 μV at 0.1 V full scale.

**Accuracy in Dc Mode** — For +25°C ±5°C.

**Range**[*1]

| | |
|---|---|
| 0.1 V | ±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading +0.04% of full scale) per °C |
| 1 V | ±0.1% of reading ±1 count. Temp coef is (±0.01% of reading +0.01% of full scale) per °C |
| 10 V and 100 V | ±0.15% of reading ±1 count. Temp coef is (±0.015% of reading +0.01% of full scale) per °C |
| 1000 V | ±0.2% of reading ±1 count. Temp coef is (±0.02% of reading +0.01% of full scale) per °C |

*[1] *Full scale*

**Accuracy in RMS Mode** — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale) per °C.

| Range | Within % of reading shown ±5 counts*[1] | | |
|---|---|---|---|
| | Dc | 40 Hz to 4 kHz | 4 kHz to 40 kHz |
| 0.1 V | 2.5% | 1.5% | 3.5% |
| 1 V, 10 V, & 100 V | 2% | 1% | 1% |
| 1000 V | 2% | 1% | 2% |

*[1] *Accuracy limit increases linearly for crest factor >2 up to twice indicated limit for crest factor of five.*

**Input Resistance** — 10 MΩ.

**Input Capacitance** — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.

**Settling Time** — Dc: 1.5 s to 0.1% of reading. RMS: 2 s to 1% of reading.

**Maximum Input Voltage**

| Range | Dc Coupled | Ac Coupled |
|---|---|---|
| 0.1 V to 10 V | 500 V*[1] | 800 V*[1] |
| 100 V to 1000 V | 800 V*[1] | |

*[1] *Dc + peak ac*

## DC AND AC CURRENT

**Range** — 0.1 mA to 1000 mA full scale in five ranges.

**Resolution** — 100 nA at 0.1 mA full scale.

**Accuracy in Dc Mode** — For +25°C ±5°C.

**Temperature Coef** — (±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.

**Accuracy in Ac Mode**

| Range | Within % of reading shown ±5 counts*[1] | | |
|---|---|---|---|
| | Dc | 40 Hz to 4 kHz | 4 kHz to 40 kHz |
| 0.1 mA | 2.5% | 1.5% | 4.5% |
| 1 mA to 1000 mA | 2.5% | 1.5% | 3.5% |

*[1] *Accuracy limit increases linearly for crest factor >2 up to twice the indicated limit for crest factor of five.*

**Settling Time** — 1.5 s to 0.1% of reading.

**Maximum Input Current** — 2 A RMS or 3 A peak on any scale (fuse and diode protection).

## RESISTANCE

**Ranges** — 1 kΩ to 10 MΩ full scale in five ranges.

**Resolution** — 1 Ω on 1 kΩ scale.

**Accuracy** — For 25°C ±5°C.

| Range | % of Reading |
|---|---|
| 1 kΩ | 0.5% ±3 counts |
| 10 kΩ to 1 MΩ | 0.5% ±1 count |
| 10 MΩ | 1% ±1 count |

**Settling Time** — Two seconds ±2 counts.

## READOUT

**Number of Digits** — 3½ digits plus decimal point and sign.

**Display Size** — 1 cm high by 4 cm wide (five characters).

**Over-Range Capability** — At least 200% of full scale.

**Over-Range Indication** — Displays scrambled characters.

# ORDERING INFORMATION

**213** Miniscope/DMM **$2,830**

**Includes:** Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two alligator clip to banana jack test leads (red 012-0015-00, black 012-0014-00); neck strap (346-0104-00); two power line fuses (159-0080-00); identification tag (334-2614-00); identification tag (000-7983-00); service manual (070-1481-00); operator manual (070-1480-00).

**Option 01** — 180 V ac to 250 V ac (48 Hz to 62 Hz) or dc. **NC**

**Includes:** In addition to above, power line plug (161-0077-01).

## OPTIONAL ACCESSORIES

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01). Order 015-0231-00 **$25**

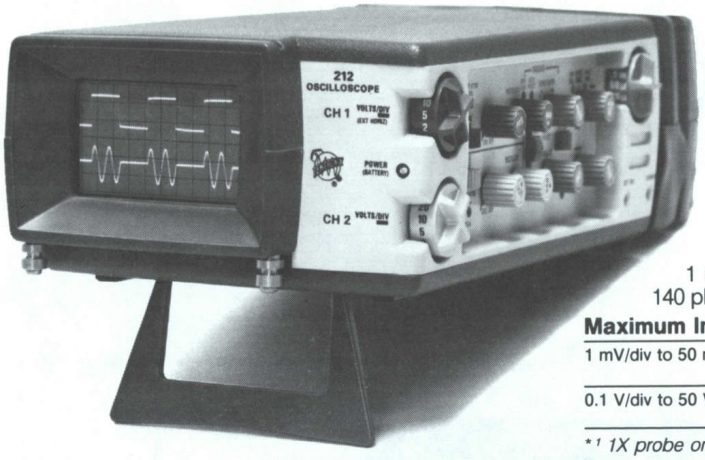
**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 **$8.00**

**Probe Tip** — To BNC Cable Adaptor. Order 103-0096-00 **$12.75**

**Power Cable Adaptor Assembly** — An 11 inch two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$6.00**



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99




# 212

**500 kHz, 1 mV/div to 50 V/div**

**Internal Battery Pack**

**Integral 1 MΩ Probe**

**Weighs ≈1.6 kg (3.5 lb)**

## TYPICAL APPLICATIONS

* **Electro-Mechanical Measurements**
* **Biomedical**

The 212 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is light weight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches).

Built of impact-resistant plastic and fully self-contained, this miniature portable is perfect for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Bandwidth** — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

**Deflection Factors** — 1 mV/div to 50 V/div (1-2-5 sequence). Accuracy: ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

**Display Modes** — CH 1 only, CH 2 only, or CH 1 and CH 2 Chopped (chop rate ≈50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

**Input R and C** — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

**Maximum Input Voltage**[*1]

| | |
|---|---|
| 1 mV/div to 50 mV/div | 600 V (dc + peak ac) ac not over 2 kHz. |
| 0.1 V/div to 50 V/div | 600 V (dc + peak ac) 600 V p-p ac 5 MHz or less |

*[1] 1X probe only*

### HORIZONTAL SYSTEM

**Time Base** — 5 μs/div to 500 ms/div, accurate ±5%.

**Variable Magnifier** — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

**External Horizontal Input** — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

**Maximum External Horizontal Input Voltage and Impedance** — Same as for vertical inputs.

### TRIGGERING

**Modes** — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity and Coupling**

| Dc Coupling | To 500 Hz |
|---|---|
| Internal (w/composite trigger source) | 0.2 div |
| Internal (w/CH 2 trigger source) | 0.2 div |
| External | 1 V |

**Maximum External Trigger Input Voltage** — 8 V (dc + peak ac), 16 V (p-p ac) at 500 kHz or less.

**Input Impedance** — R and C, 1 MΩ paralleled by ≈30 pF.

### CRT AND DISPLAY FEATURES

**CRT** — 6 x 10 div (0.52 cm/div) display. GH (P31) phosphor standard.

**Graticule** — Internal, black line, nonilluminated.

### OTHER CHARACTERISTICS

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (dc + peak ac) not to exceed 350 V.

**Power Sources** — Internal NiCd batteries provide ≈ three to five hours operation for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about ten minutes of operating time remaining in the batteries.

### POWER REQUIREMENTS

**Line Voltage Range** — 110 V ac to 126 V ac. Can be operated at 104 V ac to 110 V ac with resulting slow discharge of internal batteries. Option 01 is 220 V to 250 V. Option 02 is 90 V to 110 V.

**Line Frequency** — 58 Hz to 62 Hz. Options 01 and 02 are 48 Hz to 52 Hz.

**Maximum Power Consumption** — 3 W.

### ENVIRONMENTAL

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating from Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: 7500 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating and Nonoperating: 15 minutes along each of the three major axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — 95%, five cycles (120 hours). Referenced to MIL-T-28800C, par 4.5.5.1.2.2.

**Shock** — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.3 |
| Height | 76 | 3.0 |
| Depth | 241 | 9.5 |
| **Weights ≈** | **kg** | **lb** |
| Net (without accessories) | 1.6 | 3.5 |
| Shipping | 3.2 | 7.0 |

## ORDERING INFORMATION

**212 Dual-Trace Oscilloscope** **$2,045**
**Includes:** Integral probes, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service manual (070-5053-00); operator manual (070-5052-00).

### OPTIONS

**Option 01** — For 220 V to 250 V (48 Hz to 52 Hz). **NC**
**Includes**: Batteries.

**Option 02** — For 90 V to 110 V (48 Hz to 52 Hz). **NC**
**Includes:** Batteries.

### OPTIONAL ACCESSORIES

**10X Attenuator Package** — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 **$60**

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 **$25**

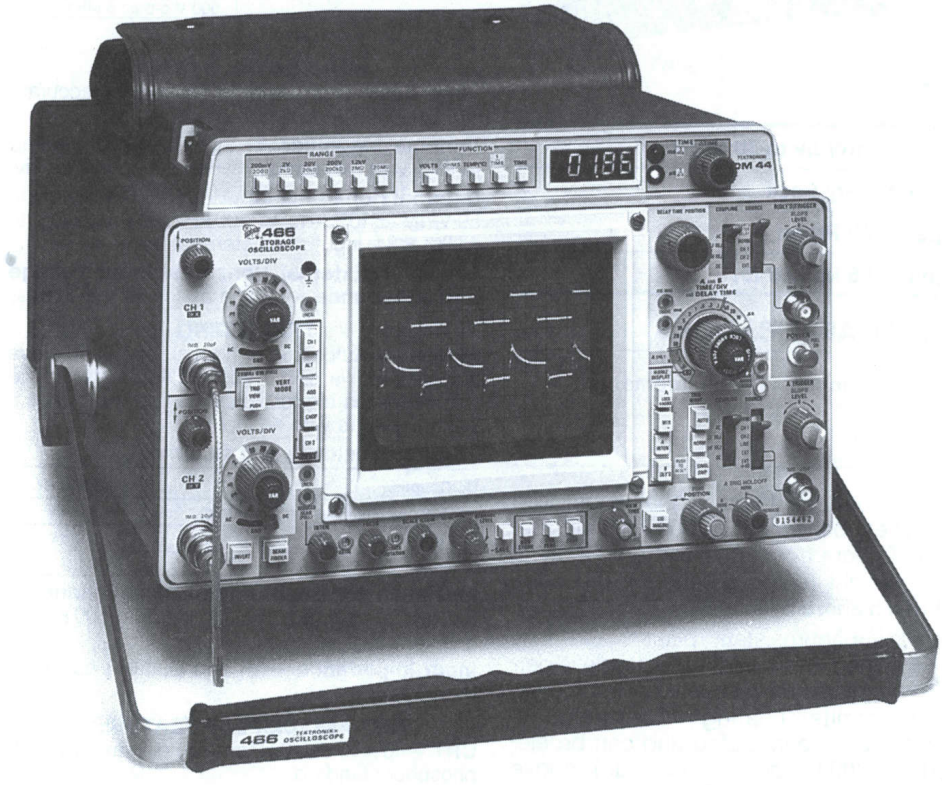
**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 **$8.00**

**Probe-Tip** — To BNC Cable Adaptor. Order 103-0096-00 **$12.75**

**Power Cable Adaptor Assembly** — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$6.00**

# PORTABLE STORAGE OSCILLOSCOPES

Tek offers a broad line of portable storage oscilloscopes, beginning with CRT storage in this section. Digital storage scopes feature three *NEW* offerings, the 2220, 2230, and 2430. These and other digital storage scopes are listed in the Digitizers section beginning on page 306.




*466 with Differential Time/DMM Option (466 DM44)*

## 466

**100 MHz at 5 mV/div**

**5 ns/div Sweep Rate with X10 Sweep Magnifier**

**Variable Persistence and Fast Mesh Transfer Storage Modes**

**3000 div/μs Stored Writing Speed**

**Battery Operation (Optional)**

**Third Channel Trigger View**

**Weighs ≈11.8 kg (26 lb)**

### TYPICAL APPLICATIONS

- **Disk/Tape Drive Logic Design**
- **Laser Pulse Analysis**
- **Low Rep Rate Radar Pulse Analysis**
- **Destructive Test Monitoring**

The 466 Portable Storage Oscilloscope is designed to display nonrepetitive or slow moving signals. And with the exception of increased stored writing speed on the 466, both instruments offer similar performance.

Operating in a reduced scan mode, the stored writing speed is 3000 div/μs (1350 cm/μs). This instrument features two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 div CRT has 0.90 cm divisions. A reduced scan 8 x 10 div graticule is superimposed over the center of the main graticule, with 0.45 cm divisions. The graticules is etched onto the inner face of the CRT to eliminate parallax problems.

A third channel trigger view allows the simultaneous display of channels 1 and 2 with the external A trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the front panel when the probe attenuation factor is switched.

Lightweight plus the ability to use optional, external dc power makes the 466 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

## CHARACTERISTICS

### VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

**Bandwidth*[1] and Risetime —** At all deflection factors from 50 Ω terminated source.

| −15°C to +40°C | +40°C to +55°C |
|---|---|
| Dc to 100 MHz, ≤3.5 ns | Dc to 85 MHz, ≤4.15 ns |

*[1] *Measured at −3 dB down. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch. Lower −3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.*

**Deflection Factor** — 5 mV/div to 5 V/div (1-2-5 sequence). Accuracy: ±3%. Uncalibrated: Continuously variable between steps and to ≈12.5 V/div. In cascade mode sensitivity is ≈1 mV/div. Cascaded bandwith is at least 50 MHz when signal out is terminated in 50 Ω.

**Display Modes** — CH 1, CH 2 (normal or inverted), Alternate, Chopped (≈250 kHz), added, X-Y.

**Common-Mode Rejection Ratio** — At least 20 dB at 20 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 MΩ ±2% paralleled by ≈20 pF.

**Maximum Input Voltage**

| | |
|---|---|
| Dc Coupled | 250 V (dc + peak ac)<br>500 V (p-p ac at 1 kHz or less) |
| Ac Coupled | 500 V (dc + peak ac)<br>500 V (p-p ac at 1 kHz or less) |

**Delay Line** — Permits viewing leading edge of displayed waveform.

## HORIZONTAL SYSTEM

**Time Base A** — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

**Time Base B** — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

**Variable Time Control** — Time Base A: Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

**Time Base A and B Accuracy*1**

| | +20°C to +30°C | −15°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

*1 *Full 10 divisions.*

**Display Modes** — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

**Calibrated Mixed Sweep** — Displays A sweep for period determined by Delay-Time Position control, then displays B sweep for remainder of horizontal sweep.

## CALIBRATED SWEEP DELAY

**Delay Time Range** — 0.2 to X10 delay Time/Div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

**Differential Time Measurement Accuracy**

| Delay Time Setting | +15°C to +35°C | −15°C to +55°C |
|---|---|---|
| Over one or more major dial div | ±1% | ±2.5% |
| Less than one major dial div | ±0.01 major dial div | ±0.025 major dial div |

**Jitter** — One part or less in 50,000 (0.002%) of X10 the A sweep time/div setting.

## TRIGGERING

**A Trigger Modes** — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

**B Trigger Modes** — B starts after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

**Time Base A and B Trigger Sensitivity and Coupling**

| Coupling | To 25 MHz | At 100 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1.5 div deflection |
| Dc External | 50 mV | 150 mV |
| Dc External ÷ 10 | 500 mV | 1.5 V |
| Ac | Requirements increase below 60 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |
| Ac HF Reject | Requirements increase below 30 Hz and above 50 kHz | |

**Jitter** — 0.5 ns or less at 100 MHz and 5 ns/div (X10 magnifier).

**A Trigger View** — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷10 source).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

**A Sources** — Normal, CH 1, CH 2 line, external and external ÷ 10.

**B Sources** — Starts after delay, normal, CH 1, CH 2, and external.

**External Inputs** — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

**Third Channel Trigger View** — Deflection Factor (Dc Trigger Coupling Only). Ext is: 100 mV/div ±5%. Ext ÷ 10 is: 1 V/div ±5%. Delay Difference: 5.0 ns ±0.5 ns after vertical display. Trigger Point: ≈ center screen. Risetime: ≤5 ns. Aberration: <10% p-p.

## X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div. Accuracy: ±4%. Bandwidth: Dc to at least 4 MHz. Phase Difference Between Amplifiers: 3° or less from dc to 50 kHz.

## CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div reduced scan. Accelerating potential is 8.5 kV (normal), 10 kV (reduced scan). GH (P31) phosphor standard.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

## STORED WRITING SPEEDS

| Full Scan*1 | Stored Writing Speed | Storage*2 View Time |
|---|---|---|
| Fast Transfer | 67.5 cm/μs | >15s |
| Variable Persistance | .225 cm/μs | >15s |
| **Reduced Scan*3** | | |
| Fast Transfer | 135 cm/μs | >15s |
| Variable Persistance | 1.35 cm/μs | >15s |

*1 *Center 6 x 8 division; 0.9 cm/division.*

*2 *These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in Save Display Mode.*

*3 *Center 8 x 10 division; 0.45 cm/division.*

## OTHER CHARACTERISTICS

**Amplitude Calibrator**

| | | |
|---|---|---|
| Output Voltage | 0.3 V | 1% +0°C to +40°C |
| Output Current | 30 mA | 2% +20°C to +30°C |
| Frequency | ≈1 kHz | |

**Vertical Signal Output** — CH 1 vertical signal is dc to at least 50 MHz and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

**Gate Outputs** — Positive gates from both time bases (≈5 V).

## POWER REQUIREMENTS

**Line Voltage Range** — Quick change, line voltage selector provides 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V ac, each ±10%. Option 07 is 12 V dc to 24 V dc.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 100 W at 115 V and 60 Hz.

## ENVIRONMENTAL

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Forced air ventilation is provided.

**Altitude** — Operating: To 4600 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 ft to 15,000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

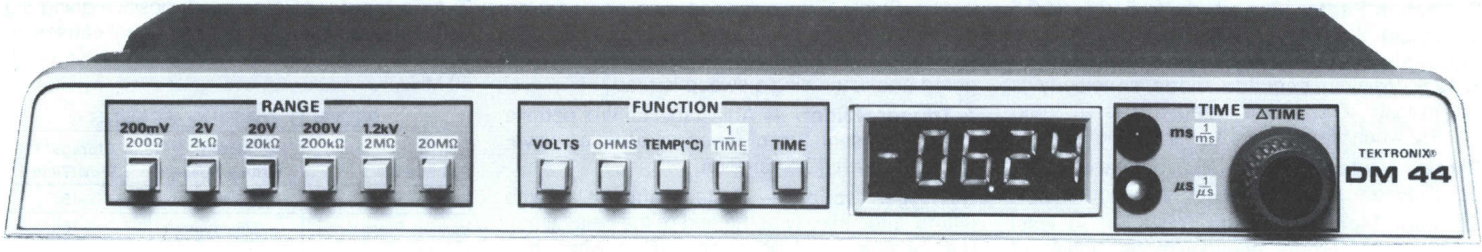
**Humidity** — Operating and Nonoperating: 95%, 5 cycles (120 hours). Referenced to MIL-T-28800C, par. 4.5.5.1.2.2.

**Shock** — Operating and Nonoperating: 30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 330 | 13.1 |
| Height (without pouch) | 159 | 6.2 |
| Depth (with panel cover)<br>Depth (handle extended) | 550<br>597 | 21.7<br>23.8 |
| **Weights ≈** | **kg** | **lb** |
| Net (without panel cover or accessories) | 11.8 | 26.0 |
| Net (with panel cover and accessories) | 13.5 | 29.8 |
| Shipping | 18.8 | 41.5 |

**See ordering information on next page.**




# DM 44

**Differential-Time/DMM Option for 466**

**3½ Digit LED Display**

**Time Intervals Accurate to 1%**

**Frequency Accurate to 2%**

**Dc Voltage Measurements Accurate to 0.1%**

**Resistance Accurate to 0.3%**

**Temperature from −55°C to +150°C**

One percent timing measurements were never this easy! With the DM 44 Option time intervals can be read directly from the 3½ digit LED screen. Simply use the Delay Time control and the ΔTime Dial to superimpose the end of the interval on the beginning. Then read its differential time or frequency from the 3½ digit LED panel. It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44. It measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to +150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

## CHARACTERISTICS

### TIMING MEASUREMENTS

**Differential Time Delay Accuracy**

| +15°C to +35°C | −15°C to +55°C |
|---|---|
| Within 1% of reading ±1 count | Within 2.5% of reading ±1 count |

**1/Time Accuracy**

| +15°C to +35°C | −15°C to +55°C |
|---|---|
| Within 2% of reading ±1 count | Within 3.5% of reading ±1 count |

### DC VOLTAGE

**Ranges** — 0 to 200 mV, 0 to 2 V, 0 to 20 V, 0 to 200 V, 0 to 1.2 kV.

**Resolution** — 100 µV.

**Accuracy** — Within 0.1% of reading ±1 count.

**Input Resistance** — 10 MΩ for all ranges. Removal of an internal strap increases resistance to ≈1000 MΩ on 200 mV and 2 V ranges.

**Normal-Mode Rejection Ratio** — At least 60 dB at 50 Hz and 60 Hz.

**Common-Mode Rejection Ratio** — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.

**Recycle Rate** — ≈3.3 measurements/s.

**Response Time** — Within 0.5 s.

**Maximum Safe Input Voltage** — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

### RESISTANCE

**Ranges** — 0 to 200 Ω, 0 to 2 kΩ, 0 to 20 kΩ, 0 to 200 kΩ, 0 to 2 MΩ and 0 to 20 MΩ.

**Resolution** — 0.1 Ω.

**Accuracy**

| Range | Accuracy |
|---|---|
| 200 Ω | within 0.25% ±1 count + probe resistance |
| 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ | within 0.25% ±1 count |
| 20 MΩ | within 0.3% ±1 count |

**Recycle Rate** — ≈3.3 measurements/s.

**Response Time**

| | |
|---|---|
| 200 Ω through 200 kΩ ranges | within 1 s |
| 2 MΩ ranges 20 MΩ ranges | within 5 s |

**Maximum Safe Input Voltage** — 120 V RMS between + and common inputs.

### TEMPERATURE USING P6430 PROBE

**Range** — −55°C to +150°C.

**Accuracy**

| DM 44 Temperature | P6430 Tip Temperature | Accuracy (Probe Calibrated to DM 44) |
|---|---|---|
| +15°C to +35°C | −55°C to +150°C | ±2°C |
| −15°C to +55°C | −55°C to +125°C<br>+125°C to +150°C | ±3°C<br>±4°C |

## ORDERING INFORMATION

**466** Storage Oscilloscope **$7,560**

**Includes:** Two P6105A probes (010-6105-13); blue accessory pouch (016-0535-02); clear pouch (016-0537-00); CRT light filter (337-1674-01); two 1½ A fuses (159-0016-00); one ¾ A fuse (159-0042-00); ground wire adaptor (134-0016-01); viewing hood (016-0592-00); operator manual (070-2037-00).

**466 DM 44**
Storage Oscilloscope/DMM **$8,260**

**Includes:** Same as 466 plus, one pair test leads (003-0120-00); one P6430 Temperature Probe (010-6430-00); service manual (070-2036-01); operator manual (070-4796-00).

**OPTIONS**

**Option 01** — Delete DM 44 Temperature Probe (466DM 44 only). **−$90**

**Option 04** — EMC Capability. **+$220**

**Option 05** — TV Sync Separator (Provides Triggering on TV Field). **+$385**

**Option 07** — External Dc Operation (Not for DM 44). **+$330**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.

## OPTIONAL ACCESSORIES

**1106** — Battery Pack (Used with Option 07.) (See page 281.) **$1,235**

**1105** — Battery Power Supply (See page 281.) **$1,650**

**Mesh Filter** — Improves display contrast in high ambient light. Order 378-0726-01 **$75**

**Protective Cover** — Waterproof vinyl. Order 016-0365-00 **$24**

**Folding Viewing Hood** — Order 016-0592-00 **$13**

**Folding Binocular Hood** — Order 016-0566-00 **$18.50**

**Polarized Collapsible Viewing Hood** — Order 016-0180-00 **$40**

**Rack Adaptor** — (Not for DM 44.) Order 016-0676-00 **$430**

**A6902B Isolator** — For floating measurements see page 437 for complete description.

**RECOMMENDED CAMERA**

**C-30BP Option 01** — General Purpose Camera. Includes 016-0301-01 mounting adaptor/corrector lens. See page 412. **$1,524**

**RECOMMENDED CARTS**

**K212 Portable Instrument Cart** — For on-site portability. See page 423. **$330**

**K117 Instrument Shuttle** — For site-to-site portability. See page 423. **$265**

**RECOMMENDED PROBES**

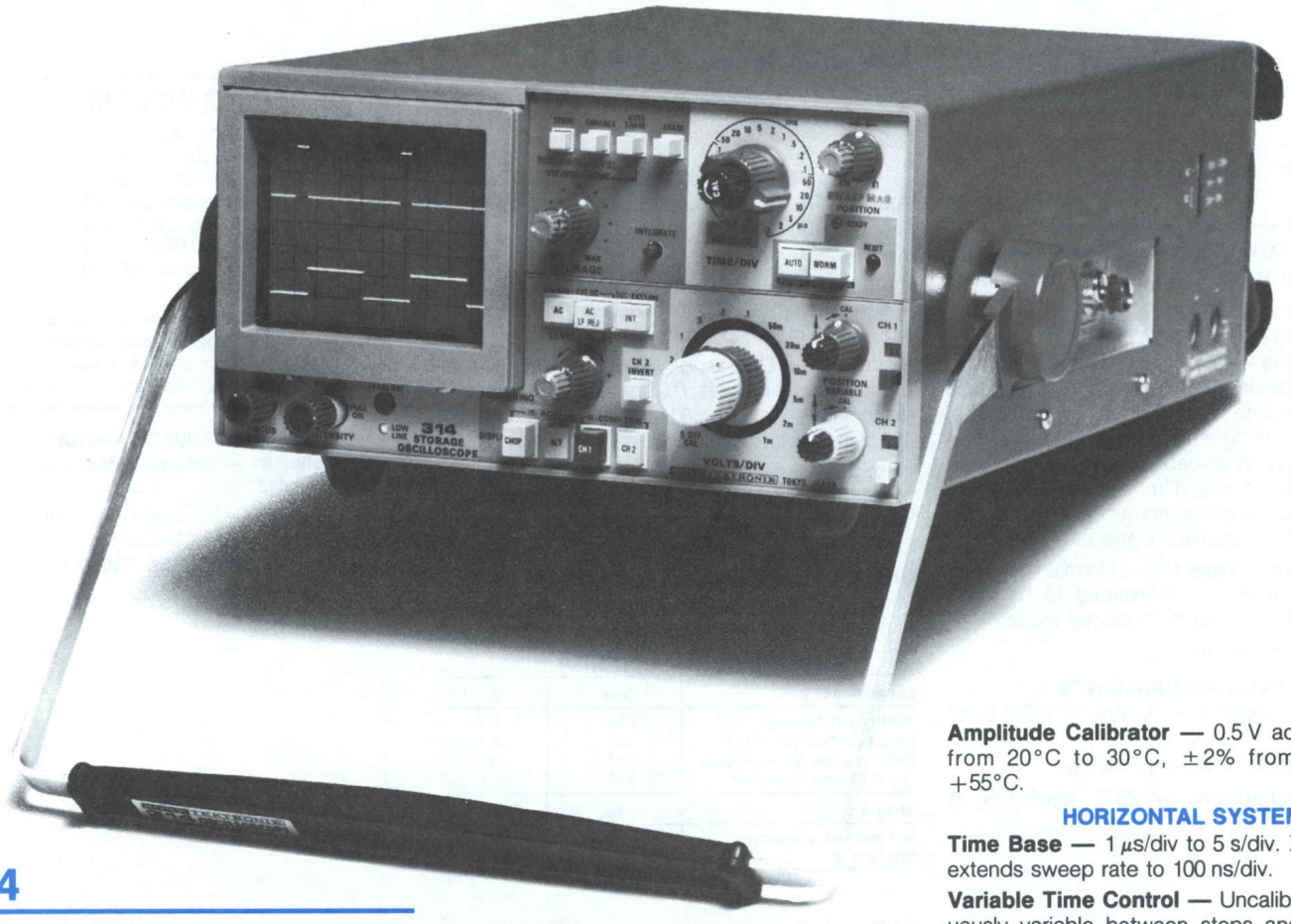
See pages 255 and 426.

Modification kits for field conversion of existing 466s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix sales engineer, distributor, or representative for information.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99




# 314

**10 MHz at 1 mV/div**

**100 ns/div Sweep Rate with X10 Sweep Magnifier**

**Stored Viewing Time to 4 Hours**

**Integrate Mode for Intensifying Fast Risetime, Low Repetition Rate Signals**

**Operates from Ac Line, 12 V Dc, or 24 V Dc**

**Small Size, Weighs ≈4.7 kg (10.5 lb)**

## TYPICAL APPLICATIONS

- **Industrial Control Systems**
- **Biophysical Instrumentation**
- **Communication Equipment Service**

The 10.5 pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a four hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast risetime, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 second to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Bandwidth and Risetime** — Dc to at least 10 MHz. Risetime: 35 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

**Deflection Factor** — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated: Continuously variable between steps to at least 25 V/div.

**Display Modes** — CH 1, CH 2 (normal or inverted), chopped, alternate, added, and X-Y.

**Input R and C** — 1 MΩ paralleled by ≈47 pF.

**Maximum Input Voltage** — Ac or dc coupled, 300 V (dc + peak ac).

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Amplitude Calibrator** — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from −15°C to +55°C.

### HORIZONTAL SYSTEM

**Time Base** — 1 μs/div to 5 s/div. X10 magnifier extends sweep rate to 100 ns/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

**Time Base Accuracy*1**

| | |
|---|---|
| **Unmagnified** | |
| 1 μs/div to 0.2 s/div | ±3% |
| 0.5 s/div to 5 s/div | ±4% |
| **Magnified** | |
| 50 ms/div to 0.5 s/div | ±5% |
| 0.5 μs/div to 20 ms/div | ±4% |
| 0.1 μs/div and 0.2 μs/div | ±5% |

*1 *Center 8 divisions*

### TRIGGERING

**Modes** — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

**Trigger Sources** — Internal: CH 1, CH 2 or composite, external.

**Sensitivity and Coupling**

| Coupling | 1 MHz | 10 MHz |
|---|---|---|
| Dc Internal | 0.3 div deflection | 1 div deflection |
| Dc External | 150 mV | 500 mV |
| Ac | Requirements increase below 30 Hz | |
| Ac LF Reject | Requirements increase below 50 kHz | |

### X-Y OPERATION

**Input** — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

**X-Axis Deflection Factors** — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

**Input Impedance** — 1 MΩ ±2% paralleled by ≈62 pF.

# SONY®/TEKTRONIX® 10 MHz DUAL TRACE STORAGE OSCILLOSCOPE

### CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 div (0.6 cm/div) display. Accelerating potential is 2 kV. GX (P44) phosphor.

**Graticule** — Internal, nonilluminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

**Z-Axis Input** — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Maximum input voltage, 50 V (dc + peak ac).

### STORAGE FEATURES

**Display Modes** — Direct view, bistable storage, and nostore modes. Enhance mode to increase stored writing rate in the single sweep mode. Autoerase mode to automatically erase stored display after each sweep. Viewing time before autoerase can be varied from 1 s or less to at least 5 s. Integrate mode increases stored brightness of very fast repetitive signals.

**Stored Writing Speed** — Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

**Erase Time** — 300 ms.

### POWER REQUIRMENTS

**Line Voltage Ranges** — 90 V ac to 130 V ac or 180 V ac to 264 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption** — 29 W maximum at 115 V ac.

**External Dc Source** — +11 V dc to + 14 V dc or +22 V dc to +28 V dc.

**Dc Current Drain** — 1.6 A at +12 V or 0.8 A at +24 V.

### ENVIRONMENTAL

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

**Altitude** — Operating: 6000 m (20,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 15 000 m (50,000 ft) maximum.

**Vibration** — Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles.

**Humidity** — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

**Shock** — Operating and Nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 236 | 9.3 |
| Height (without pouch) | 112 | 4.4 |
| Depth (handle not extended) | 347 | 13.6 |
| Depth (handle extended) | 448 | 17.6 |
| **Weight ≈** | **kg** | **lb** |
| Net (without accessories) | 4.7 | 10.5 |
| Shipping | 7.6 | 17.0 |

### ORDERING INFORMATION

**314** Storage Oscilloscope **$4,315**

**Includes:** Two P6149A 10X probes (010-6149-13); carrying case and pouch (016-0612-00); strap (346-0131-02); external dc cable assembly (012-0406-00); two 1.6-A fuses (159-0098-00); two 0.8-A fuses (159-0132-00); two 0.15-A fuses (159-0130-01); three 0.16-A fuses (159-0131-00); service manual (070-1824-00); operator manual (070-1823-00).

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### RECOMMENDED CAMERA

**C-30BP Option 01** — General Purpose Camera. See page 412. **$1,524**

**Camera Adaptor** — Required to mount the C-30BP to the 314. Order 016-0327-01 **$170**

### RECOMMENDED PROBES

See pages 255 and 427.

**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

# TEK 500 kHz DUAL TRACE STORAGE OSCILLOSCOPE

200 SERIES MINISCOPES

## 214

**500 kHz, 1 mV/div to 50 V/div**

**Internal Battery**

**Integral 1 MΩ Probe**

**Weighs ≈1.6 kg (3.5 lb)**

### TYPICAL APPLICATIONS

* **Industrial Control Systems**
* **Electro-Mechanical Measurements**

The 214 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.3 x 9.5 inches). The 214 offers bistable storage capabilities. This is useful for viewing nonrepetitive or slow moving signals.

Built of impact-resistant plastic and fully self contained, this miniature portable is ideal for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

## CHARACTERISTICS

### VERTICAL SYSTEMS

**Bandwidth** — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower −3 dB point ac coupled is ≈2 Hz.

**Deflection Factors** — 1 mB/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated: Continuously variable between steps to at least 125 V/div.

**Display Modes** — CH 1 only. CH 2 only, or CH 1 and CH 2 chopped (≈chop rate—40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

**Input R and C** — ≈1 MΩ paralleled by ≈160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

**Maximum Input Voltage**[*1]

| | |
|---|---|
| 1 mV/div to 50 mV/div | 600 V (dc + peak ac) ac not over 2 kHz |
| 0.1 V/div to 50 V/div | 600 V (dc + peak ac) 600 V p-p ac; 5 MHz or less |

*[1] *1X Probe Only*

### HORIZONTAL SYSTEMS

**Time Base** — 5 μs/div to 500 ms/div, accurate ±5%.

**Variable Magnifier** — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

**External Horizontal Input** — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

**Maximum External Horizontal Input Voltage and Impedance** — Same as for vertical inputs.

**Input Impedance** — R and C, 1 MΩ paralleled by ≈30 pF.

### TRIGGERING

**Trigger Modes (Automatic or Normal)** — Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity and Coupling**

| Dc Coupling | To 500 Hz |
|---|---|
| Internal (w/composite trigger source) | 0.2 div |
| Internal (w/CH 2 trigger source) | 0.2 div |
| External | 1 V |

**Maximum External Trigger Input Voltage** — 8 V (dc + peak ac), 16 V (p-p) at 500 kHz or less.

**Single Sweep** — Sweep generator produces one sweep when trigger is received.

### CRT AND DISPLAY FEATURES

**CRT** — Bistable storage, 6 x 10 div (0.52 cm/div) display. GX (P44) phosphor.

**Graticule** — Internal, black line, nonilluminated.

### STORAGE FEATURES

**Stored Writing Speed** — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

**Stored Luminance** — At least 8 fL at 25°C.

**Storage Viewing Time** — ≈1 hour.

### OTHER CHARACTERISTICS

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 times line voltage + dc + peak ac not to exceed 350 V.

**Power Sources** — Internal NiCd batteries provide ≈3.5 to 5 hours operation (≈2.5 to 3.5 hours in 214 stored mode) for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 minutes of operating time remaining in the batteries.

### POWER REQUIREMENTS

**Line Voltage Range** — 110 V ac to 126 V ac. Can be operated at 104 V to 110 V with resulting slow discharge of batteries. Option 01 is 220 V to 250 V. Option 02 is 90 V to 110 V.

**Line Frequency** — 58 Hz to 62 Hz. Options 01 and 02 are 48 Hz to 52 Hz.

**Maximum Power Consumption** — 3 W.

### ENVIRONMENTAL

**Ambient Temperature** — Operating (Battery Only): −15°C to +55°C. Charging or Operating From Ac Line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating and Nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 Hz to 55 Hz to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — 95%, 5 cycles (120 hours). Referenced to MIL-T-28800C, par. 4.5.5.1.2.2.

**Shock** — Operating and Nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 133 | 5.3 |
| Height | 76 | 3.0 |
| Depth | 241 | 9.5 |
| **Weight≈** | **kg** | **lb** |
| Net (without accessories) | 1.6 | 3.5 |
| Shipping | 3.2 | 7.0 |

## ORDERING INFORMATION

**214** Dual-Trace Storage Oscilloscope **$2,795**

**Includes:** Integral probe, batteries, viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00); service manual (070-5055-00); operator manual (070-5054-00).

### OPTIONS

**Option 01** — For 220 V to 250 V (48 Hz to 52 Hz). **NC**

**Option 02** — For 90 V to 110 V (48 Hz to 52 Hz). **NC**

### OPTIONAL ACCESSORIES

**10X Attenuator Package** — A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac). Includes: flex tip (206-0060-00); 10X attenuator (010-0378-01); pincher tip (013-0071-00); banana tip (134-0013-00); IC adaptor (206-0203-00). Order 010-0378-01 **$60**

**Alligator Clip Kit** — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: 6-32 to probe adaptor (103-0051-01); red clip (015-0229-00); yellow clip (015-0230-00). Order 015-0231-00 **$25**

**Probe-Tip** — To BNC Panel Connector Adaptor. Order 013-0084-01 **$8.00**

**Probe-Tip** — To BNC Cable Adaptor. Order 103-0096-00 **$12.75**

**Power Cable Adaptor Assembly** — A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied. Order 161-0077-01 **$6.00**

# AUTOMATED TEST SYSTEMS AND INSTRUMENTS



## CONTENTS


Programming Ease ..... 295
Systems Support ..... 297
Controllers and Peripherals ..... 298
SPS Basic Software ..... 301
TEK EZ-TEST Software ..... 304
GURU Software ..... 305
Digitizers ..... 306
Measurement Systems ..... 330
TM 5000 Modular Instruments ..... 338


Tektronix offers a variety of programmable measurement instruments to meet your measurement needs. Starting with a wide performance base of GPIB compatible waveform digitizers, with capabilities up to 14 GHz. And, with the 7D20 digitizer plug-in, your existing Tektronix 7000 Series oscilloscope can become a GPIB programmable waveform digitizer—another example of our designed-in commitment to expandability.

Plus, we have a broad range of other GPIB programmable instruments to complete your system—signal and power sources, measurement devices, switchers, spectrum analyzers, multifunction interface units. And they are all supported by a selection of instrument controllers, peripherals, and software.

We provide extensive and ongoing documentation—hardware and software manuals, controller programming guides, instrument interfacing guides, application notes, even a regular newsletter on signal processing and instrument control. In addition, an instrumentation software library provides programs to help you develop measurement software to solve your measurement problems.

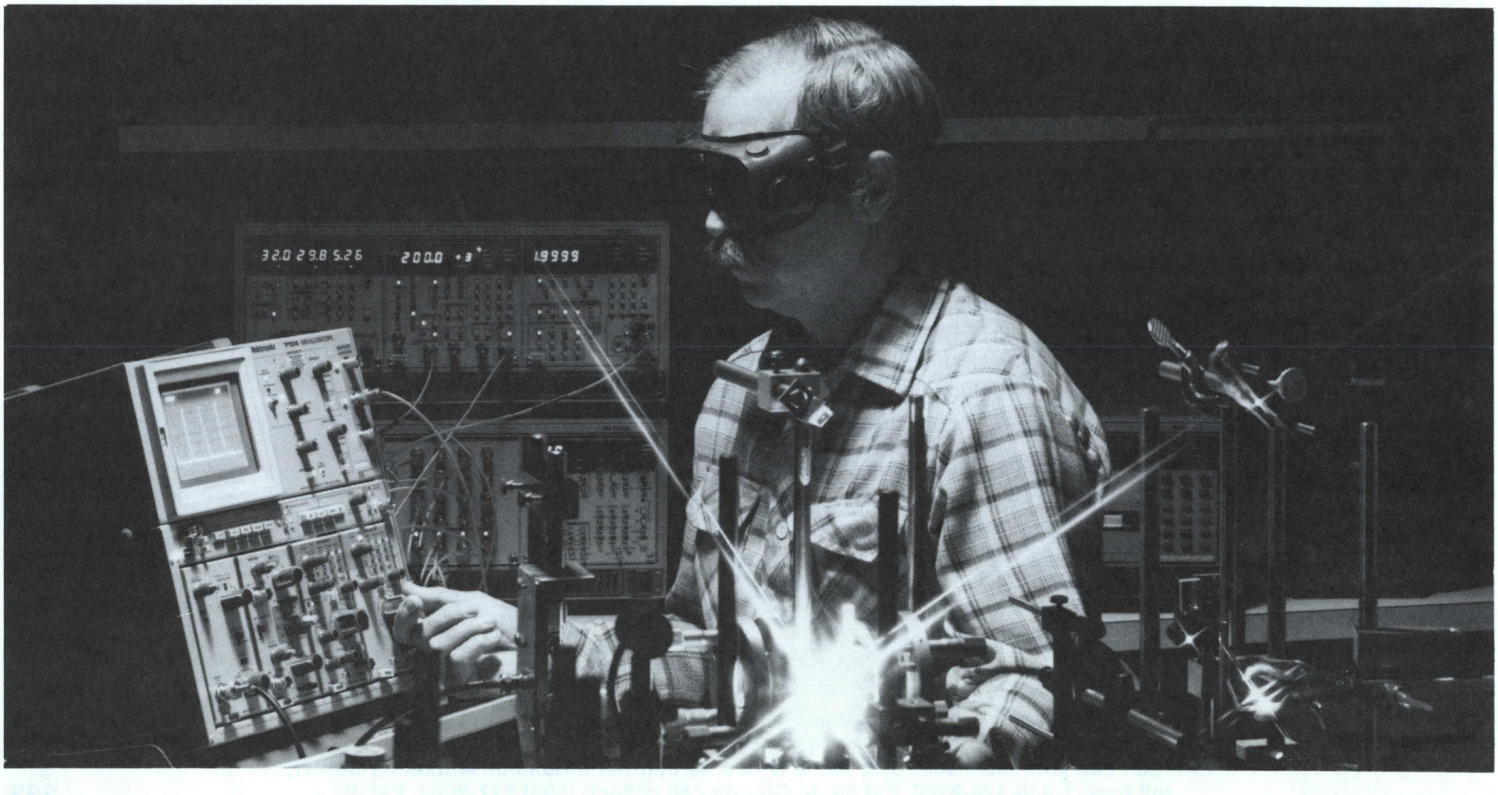
**Configurability**

Tek systems offerings afford maximum flexibility, right down to the number of ways in which they may be configured.

1. Individual systems components are orderable separately and include instrument interfacing guides, documentation, and in some specific cases, application software available through the Tektronix Instrument Software Library.
2. Preconfigured measurement packages (MP) make it easy to purchase the most-needed components in a packaged system that you integrate and install yourself. Instruments contained in measurement packages carry the normal, stand-alone instrument warranty and do not include on-site installation.
3. Factory-integrated measurement systems (MS) are, in many cases, a cost-effective alternative to developing systems yourself. They are assembled and tested at our factory and include on-site installation, 90-day on-site system warranty, training credit and system checkout software.
4. Custom systems are generally modified/expanded versions of our standard packages and include integration, checkout software, on-site installation and warranty. They do not include device-specific application software.

Tek documentation is extensive and on-going. It includes hardware and software manuals, programming guides, interfacing guides, application notes, even a regular newsletter on instrument control and signal processing.

Whatever your needs, from a single GPIB instrument to a complete measurement system, we're sure you'll find the right measure of performance in the pages that follow. Take the time to evaluate your own unique needs —and our uniquely personal solutions. You'll be making an investment in performance that will pay dividends for years.



# PROGRAMMING EASE . . .

## Another Order of Magnitude in Measurement Convenience

## Tektronix *Standard Codes and Formats*...

## A Commitment to Compatibility

**Tektronix Programmable Instruments Speak Your Language**

With Tektronix programmable instruments, compatibility is the key. And it's more than just IEEE Standard 488 compatibility. It's total system compatibility, from configuring to programming. This higher level of compatibility is achieved through conformance to the additional standard of Tektronix *Standard Codes and Formats*. Tektronix *Standard Codes and Formats* extend compatibility through:

—An ASCII-coded language for easy, English-like programming.
—Command names that are descriptive abbreviations of instrument functions for simple and direct instrument control.
—Universal message and data formats for instrument-to-instrument consistency.

In short, Tektronix programmable instruments speak a system language that is the same as your language.

Need to set your power supply to 5 volts?

It's easy with the TM 5000 Series PS 5010 Programmable Power Supply. Just send the message VPOS 5 over the IEEE Standard 488 Bus to the power supply, and it will change its positive output to 5 volts.

Want to set the negative supply to −9 volts? Just send VNEG 9, or even VNEG −9. All Tektronix programmable instrument commands are simple, English abbreviations for the instrument functions, with direct matches to the front-panel control labels where appropriate. So, if you know how to operate the instrument, you essentially know what commands to send it.

What could be simpler than DCV .2 to change your TM 5000 DM 5010 Programmable Multimeter to the 200 mV range for dc voltage measurements? Or ACV 2 to switch it to the 2 V range for ac measurements? But then, you may not always be sure of the range you need. So just send DCV or ACV without specifying the range, and the multimeter will auto-range to give you the best measurement. You don't have to learn a new language to speak to an instrument or understand instrument control messages—they're self documenting.

**Getting Your Message Across**

It doesn't take long to become familiar with the command set for any Tektronix programmable instrument. And, once you have that familiarity, you'll want to begin actually programming for automated measurements. First, though, you'll need to know something about IEEE Standard 488 Bus communication.

IEEE Standard 488 specifies overall bus functions, leaving many implementation options to designer discretion. One option is how controllers and instruments signal message endings to each other. Some controllers end messages by asserting End Or Identify (EOI) concurrent with sending the last character of a message, others by adding a line feed (LF) character and asserting EOI concurrent with that. For compatibility, your instruments and controller must use the same message termination mode.

Whatever your choice of IEEE Standard 488 instrument controller, Tektronix programmable instruments are designed for compatibility. A switch on each Tektronix programmable instrument lets you match it to your controller by selecting the EOI only or EOI/LF message termination mode. But, if you've chosen a Tektronix controller, you won't have to bother with this switch. All Tektronix-supplied instrument controllers use EOI only, and all Tektronix programmable instruments are shipped set for EOI only.

Along with the Message Terminator switch, you'll also find that Tektronix programmable instruments have a bank of at least five additional switches or front panel push buttons to set the instrument's primary bus address.

For an IEEE Standard 488 system to work, each instrument on the bus must have a different address. Valid addresses range from 0 to 30, with 0 reserved in some cases for the controller. Before connecting your Tektronix programmable instrument to the IEEE Standard 488 Bus, make sure each instrument is set to a different address. For most Tektronix instruments, address checks can be done with a front-panel button. Pressing the button causes the address to appear on the instrument's display. Some instruments also display their message terminator setting.

The primary address links the controller to a specific instrument. For example, when using a Tektronix 4041 System Controller with 4041 BASIC Software, just primary addresses are used. 4041 BASIC automatically converts primary addresses to talk and listen addresses. For example, a 4041 BASIC statement to send VPOS 5 to a PS 5010 Programmable Power Supply with a primary address of 22 would have the following format:

```
PRINT #22:"VPOS 5"
```

PRINT is the 4041 BASIC statement for sending a message to an instrument. The instrument's primary address, 22 in this case, is always preceded in the statement by an # symbol and followed by a colon. The instrument message, VPOS 5, follows the colon and is always enclosed in quotes. Since the instrument will be receiving the message, PRINT causes the primary address to be automatically incremented to a listen address.

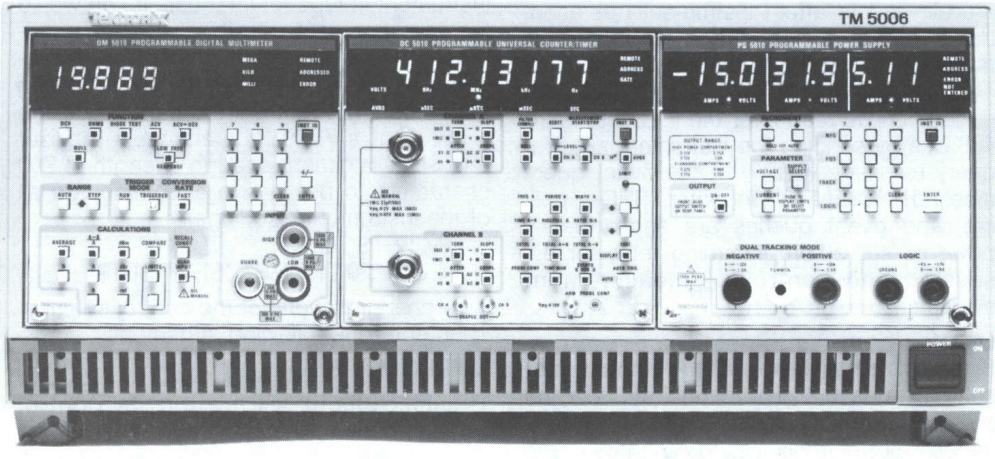
Keep in mind, though, PRINT #22:"VPOS 5" is a statement format specific to 4041 BASIC. Other instrument controllers and software packages may use different statement formats, however the device dependent message is always the same. For example, in TEK SPS BASIC the following statement would be used: PUT "VPOS" into #22.

**We Interrupt This Message For a Brief Program**

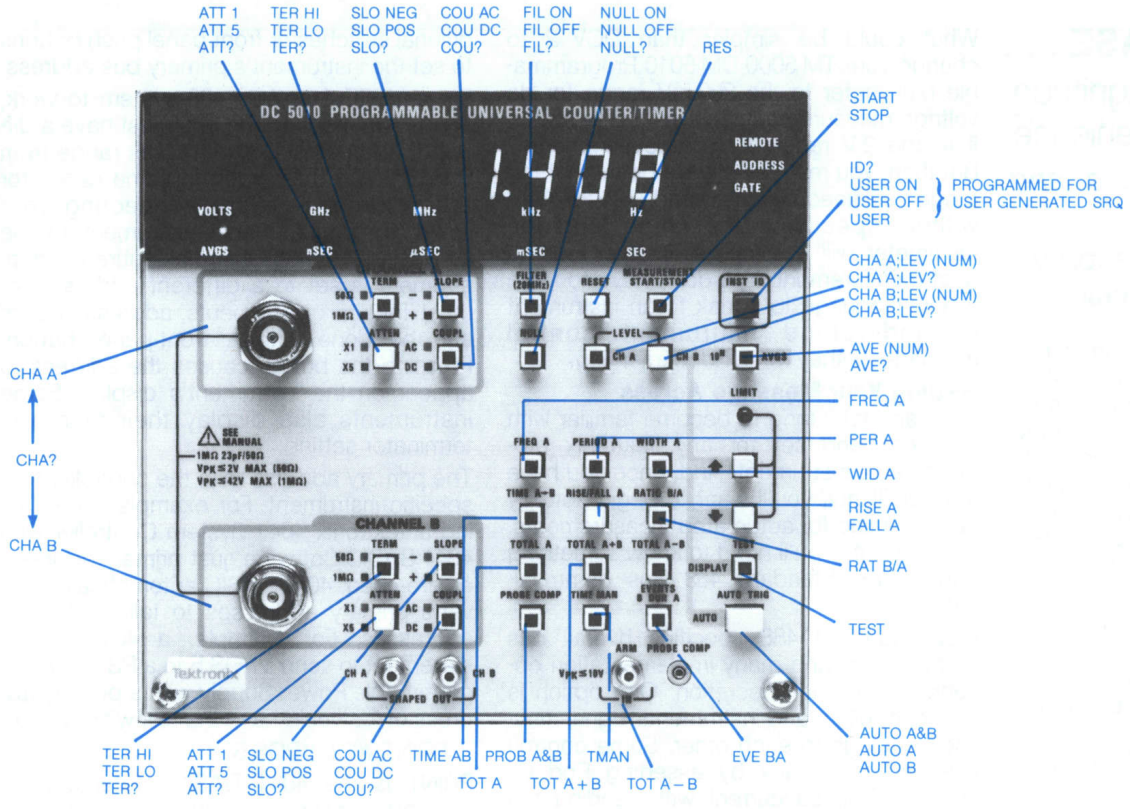
In addition to being easy to program, Tektronix programmable instruments are friendly and informative in respect to sending SRQ interrupts.

With the basic message format in mind, you are ready to begin sending messages to your instruments. However, you should be aware that your instruments can occasionally interrupt what you are doing by asserting what is called an SRQ (Service Request).

On some Tektronix programmable instruments, a front-panel button can also be programmed to generate an SRQ when pressed. This manually generated SRQ is a convenient way for you to interrupt and interact with a measurement program while it is running.




*TM 5000: IEEE Standard 488 compatibility in an attractive, high-density package for minimum use of bench top or system rack space.*




*Tektronix* ***Standard Codes and Formats*** *mean friendly "front panel" commands for easy programming.*

This can be done with a serial poll, which is demonstrated in the following 4041 BASIC program example:

```
100 ON SRQ(1) THEN GOSUB SRQHAN
110 PRINT #16:"ACV"
120 PRINT #10:"TR HOLDNEXT ON"
130 ■
140 ■
150 ■
1000 SRQHAN: POLL STATUS, ADDRESS;
16; 10
1010 RESUME
```

Line 100 in the above example sets up a condition that calls the SRQ handler routine "SRQHAN" whenever an SRQ is asserted. In the absence of an SRQ, the normal path of the program is taken. However, on an SRQ, the program branches to the SRQHAN subprogram, which contains a Poll statement. The Poll statement checks each instrument in the order of listed addresses to find the one asserting SRQ. When it finds the instrument with SRQ asserted, it services the SRQ by reading the instrument's status message into the status variable (STATUS in line 1000). Also, the instrument's address is placed in variable ADDRESS. (From these two variables, you can then tell which instrument asserted SRQ and why.) When the Poll completes, the Resume in line 1010 causes program execution to return to where it was when the SRQ caused the interrupt.

In an actual programming situation, you may want to check the status code variable, STATUS, and base some action on its value before returning to the main programs. To make this easier, Tektronix programmable instruments all use the same status codes for universal conditions. For example, no matter what Tektronix programmable instrument you are using, 66 is the code for operation complete. A full list of status codes and their meanings is provided in each instrument manual.

Tektronix programmable instruments also have an error code scheme that allows individual instruments to expand on the universal system status codes. This expansion is the result of an extensive message decoding system that checks for syntax errors, illegal combinations, etc., before messages are allowed to affect instrument operation. Illegal setups are prevented, and specific, rather than generalized, error codes are available for each instrument. These error codes can be read over the IEEE Standard 488 Bus by sending the instrument an error query message (ERR?) or the event query message (EVENT?). Together, SRQs, polling, and event queries are an extremely powerful set of programming tools for assessing and controlling measurement systems.

### Queries Keep You Posted

Specific information about instrument settings, measurement modes, etc., can be obtained with various instrument query messages. All Tektronix *Standard Codes and Formats* queries take the form of a keyword followed by a question mark. You send the query to the instrument as a message, and the instrument answers the query by returning a message over the bus.

For example, here's a query sequence in 4041 BASIC statements to obtain the trigger setting of a 7D20 Programmable Digitizer:

```
INPUT #22 PROMPT
"TRIG?":TRSET$
```

The statement starts by asking: "What are your trigger settings?" The instrument answers by getting the settings and putting them onto the bus as a message: TRSET$. The Input statement is the means of receiving the message and storing it in string variable TRSET$. When a string variable (variable name followed by $) is used with the Input statement, the entire message is stored in the variable.

Perhaps you are interested in all the control settings of an instrument. SET?, a universal query for all Tektronix *Standard Codes and Formats* instruments, causes the queried instrument to send a message that lists all of its current settings. This entire settings message can then be stored in a string variable. You can acquire and store a number of instrument configurations in different string variables. Then, just by sending the appropriate string variable to an instrument, the instrument can be reset at any time to any of the stored configurations. (Since the settings message can be several hundred characters long, it may be necessary with some software packages to extend or dimension the string variable to a length capable of holding the message.)

In essence, SET? is a "learn mode" of operation. It allows you software to "memorize" instrument setups for later use. If you would like to experiment with this, set your instrument to a familiar measurement configuration. Using 4041 BASIC, enter the following statements (20 is assumed here to be the address of a 7D20 Programmable Digitizer and SET$ is dimensioned to a length of 700 characters to be sure to accommodate all of the instrument's settings):

```
DIM SET$ TO 700
INPUT #20 PROMPT "SET?":SET$
```

Now change several of the control settings. Then enter the following statement:

```
PRINT #20:SET$
```

The instrument will switch its control settings back to those stored in SET$.

To see what is in SET$, just enter SET$. The entire settings message will be printed out on the terminal screen for your inspection.

Each Tektronix programmable instrument responds to a variety of queries, each query consisting of a keyword specific to the information desired. If you would like to know what measurement function your DM 5010 Programmable Digital Multimeter is set up for, just send it "FUNC?". The DM 5010 will prepare to send back DCV, OHMS, DIODE, ACV, or ACDCV and the measurement range the function is set for. Send the same query to your FG 5010 Programmable 20 MHz Function Generator, and it will prepare to send back FUNC SINE, FUNC SQUARE, or FUNC TRIANGLE, depending on the waveform it is generating; another example of how Tektronix *Standard Codes and Formats* instruments work with you in plain English.

A significant added value in a Tektronix system is support—software, interfacing, training, service, and application support. Whatever your support needs, for individual programmable measurement instruments or for complete systems, we can help. And it's all available from one source—Tektronix.

## TEKTRONIX INSTRUMENTATION SOFTWARE LIBRARY

The Tektronix Instrumentation Software Library provides software and application information to aid in the planning, design, and implementation of measurement solutions using programmable measurement instruments and systems. Currently it contains three types of software—and more are planned.

### Measurement Software

Provides solutions to measurement problems using programmable measurement instruments or systems. Measurement Software is user-friendly and ready to run, requiring minimal software integration or modification. Measurement Software is provided only on media*[1].

### Instrument Utility Software

This is a set of subroutines and subprograms that perform common instrument functions. A single instrument/controller combination is addressed by each subroutine or subprogram. Instrument Utility Software is well documented and presented in a consistent format so it can be easily modified and integrated into application programs that you develop. Instrument Utility Software is provided only on media*[1].

### User-Exchange Software

Developed by users to perform specific measurements or functions with programmable measurement instruments or systems. User-Exchange Software is available either on media*[1] or as listings at no charge.

### The Tektronix Instrumentation Software Library Catalog

Contains abstracts and ordering information for available software. For a copy of the latest catalog, ask your Tektronix sales representative for Tektronix literature number 45W-5570.

*[1] *Contact your local Tektronix sales representative for complete ordering information and prices.*

## INTERFACING AND OPERATING SUPPORT

Tektronix provides documentation to help build and use your measurement system. Whether it's interfacing, programming, operation, or maintenance, you'll find what you need in documentation from Tektronix.

### Instrument Interfacing Guides

These serve as a system integration guide by aiding in instrument configuration, connection, and operation with a controller. Specific information on the GPIB operation of the instrument along with programming examples are provided. Designed to supplement the operator's manual, they are supplied free of charge with the instrument.

### Controller Programming Guides

Supplying an additional aid to GPIB system integration, these programming guides provide specific information and guidelines on a controller's GPIB operating capabilities, as well as suggestions for getting the best performance from your instrument/controller combination. Sample programs are used to demonstrate various aspects of GPIB operation and to show the processing power of the controller.

### Operator's and Service Manuals

A standard accessory with each Tektronix instrument and system, these documents provide complete and comprehensive information so you can operate and service your Tektronix measurement system.

## PROGRAMMABLE INSTRUMENTS NEWSLETTER

### *HANDSHAKE*

This applications newsletter is for signal processing and programmable instrument control. Published quarterly, it contains technical articles on measurement processes, techniques, and instruments. Subscriptions to *HANDSHAKE* are free upon request from your Tektronix sales representative.

### *TM NOTES*

This is a quarterly publication addressing TM 5000 and TM 500 users. Designed to keep readers informed on new products, new measurement techniques, and new applications for existing products, *TM NOTES* keeps existing and potential TM 5000/TM 500 users up to date on programmable and manual test instrumentation. Subscriptions are free upon request from your local Tektronix sales representative.

## ONGOING SUPPORT

Tek's system support doesn't stop when you receive your programmable measurement instrument or system. Our support continues throughout its lifetime through training, application assistance, software support, and service.

### Training

To help operators better understand their equipment and get the most out of their systems, training is available both at the home office and at selected sites around the world. In addition, in-depth service training is available for those companies who want to learn to service their own Tek equipment.

### Application Assistance

To help solve unique measurement problems our applications assistance is as near as your telephone. If your measurement needs are not answered by our standard software and documentation, Tektronix applications assistance is available in many areas of the U.S. and around the world to help design a solution just to fit your need.

### Software Support

To keep your software current and up-to-date, our software support is available at no charge during the warranty period. Post-warranty software support is available on a subscription basis.

### Service

For your programmable measurement instrument or system, service is available from Tektronix Service Centers at strategic locations throughout the world. You'll always receive expert assistance from some of the most highly trained and qualified personnel in the world.

For more information on any of the support available for Tektronix programmable measurement instruments or systems, contact your local Tektronix sales representative for details.

## A Controller to Match Your Instrumentation System Needs

The one common element that binds both large and small instrumentation systems together is the system controller. Tektronix offers a number of IEEE Standard 488 Controllers to fit your system needs. The system, or instrument controller, is in reality just a computer that has been designed to optimize the interaction and communication between the controller and a wide variety of programmable instruments and peripherals. This interaction is enhanced by instrument control commands in a high-level programming language such as BASIC, eliminating the need for the user to understand the IEEE Standard 488 Interface protocol in detail. The user only needs to supply the instrument address and the function to be performed. The controller automatically takes care of the rest—interface handshaking, bus states and transitions, etc.

The ideal controller for a particular use depends upon the specific requirements of the application. Such varied applications as laboratory automation, manufacturing test, QA/QC, service/repair, and environmental data acquisition/analysis each have unique controller requirements. Some applications require little or no operator interaction and perform repetitive tasks over and over again. For these cases, a tamper-proof execute-only controller capable of running unattended with little or no display requirements is often very desirable.

The other end of the application spectrum may require a large amount of operator interaction for developing programs, providing operator prompts and instructions, reviewing intermediate or final test results, and making changes in the test setup based upon test results. Where graphics are helpful as an analysis tool, a controller with an integrated display screen may be the best choice.

Expandability and flexibility is another important consideration in choosing an instrument controller. For example, controllers without an integral CRT for display allow you to select the exact display features which best suit the requirements of the application. For program development, a low-cost alphanumeric-only terminal may be best. However, for interactive applications or data analysis and interpretation, a graphics terminal, perhaps with color, would be a better choice. This ability to choose screen size, resolution, number of lines, color, and other display parameters greatly enhances the controller's capability.

Likewise, the ability to add memory, program ROMs, system peripherals, etc., greatly enhances a system controller's capabilities. This expandability will allow you to reconfigure your system to meet future measurement needs as applications change.

Whatever your current or future instrumentation system needs, Tektronix controllers provide a choice to allow systems to be configured with the right operator interface, memory, display, hardware interfaces, and peripheral support.

## 4041 System Controller

GPIB IEEE-488

The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**Easy to Use Extended BASIC**

**512 kbytes Memory Standard**

**ROM Packs Enhance the 4041 in the Areas of Graphics and Signal Processing, Other Utilities are Also Available**

**Easy to Configure with any IEEE Standard 488 Instrument**

**Execute Only Mode for Program Security on the Production Floor**

**Detachable Keyboard (Option)**

**Modular Design—Rackmount or Portable**

**Flexible and Hard Disk Support with the NEW 4041 Disk Drive Unit**

The Tektronix 4041 System Controller is a powerful and flexible IEEE Standard 488 (GPIB) Controller. It is designed to work with Tektronix and other GPIB instruments. The 4041 System Controller standard configuration has an execute only mode that enhances program security in a production environment. Interface, port, and ROM pack options increase the flexibility of the 4041. The standard 4041 is equipped with a GPIB interface port and an RS-232C serial interface port that is compatible with most terminals, including the full line of Tektronix graphics and alphanumeric terminals. The Extended BASIC Language, also included with the 4041, is easy to use while maintaining the required depth needed for complex programs.

### 4041 Hardware

The 4041's main processor is the powerful 16-bit 68000 with 512 kbytes of standard memory. The versatile front panel of the 4041 is ideal for standalone applications. It includes a 20-character alphanumeric display, 18 key keyboard, DC100 tape drive, and 20-character thermal printer. On the rear panel is the standard GPIB interface port and an RS-232C serial port.

Several options are available to increase the 4041's capabilities. Option 01 adds another RS-232C serial interface and a second GPIB interface port, which can be configured for DMA transfers, allowing fast data transfers across the GPIB bus. Option 03 provides an interface to the *NEW* 4041 Disk Drive Unit and a second RS-232C interface.

Optional ROM packs expand the existing Basic language by providing commands for creating graphics and processing digitized waveforms—capabilities ideal for signal processing systems. The list of options include:

- Optional DMA GPIB interface port/ RS-232C interface port (Option 01)
- 8-bit parallel TTL interface port (Option 02)
- Mass storage disk interface/RS-232C port interface (Option 03)
- ROM packs 4041R01, 4041R02, 4041R03, 4041R04, installed internally (Option 10)
- Program development ROMs and ROM carrier (Option 30)
- Program development/debug keyboard (Option 31)

Option 30 is required for program development. Its inclusion as a ROM pack makes it easy for a test engineer or system developer to convert an execute only 4041 into a development station for debugging, editing, or adding program statements, and then converting back to an execute only system for operation after the desired program changes have been made.

For extensive program development, the 4041 can be configured so that its RS-232C port is the console. This allows a separate terminal to be used for program development and execution. The 4041 has a complete line editor to allow insertion, deletion and movement in the line.

The mechanical package of the 4041 is ideal for integration into a system environment. Its small size and ability to be rackmounted allows for easy installation into a system. Combining a 4041 with a TM 5003, 7D20T, or 4041 Disk Drive Unit into a standard 19 inch wide rackmount package results in a compact system with powerful capabilities.

**4041 BASIC**

4041 BASIC is a powerful, easy to use language, excellent for instrument control. It has easy to use high level GPIB commands in addition to low level commands required for the most complex applications. English-like syntax and interpreted environment are combined to provide an easy to use, friendly, programming language. To improve self-documentation the 4041 has the following features.

- Variable names up to eight characters
- FORTRAN-like subprograms calls
- Variable passing from main programs to subprograms
- Local and global variables

Other powerful features include optional data types (integer, short floating point and long floating point); a proceed mode which allows I/O and processing operations to run independently for maximum speed; logical unit number and stream specifications to define and characterize I/O oriented tasks; and 512 kbytes of directly addressed memory (without use of expensive overlays or paging techniques).

**4041 ROM Packs**

Option 10 incorporates the function of the ROM packs (4041R01, 4041R02, 4041R03, and 4041R04) internally, allowing the ROM tray to be used as a ROM program loader.

The 4041R01 Graphics ROM pack provides high level commands to easily construct graphic images, symbol, charts and diagrams into system applications.

The 4041R02 Plotting ROM Pack plots data, draws the axis and tic marks, and draws and scales graphs with very little programming knowledge. The 4041R01 is required for this ROM pack to operate.

The 4041R03 Signal Processing ROM Pack provides high level commands for signal processing applications which include the following functions:

- Fast Fourier Transforms (FFT)
- Inverse Fourier Transforms (IFT)
- Integration
- Differentiation
- Correlation
- Convolution

Combine these capabilities with those of the graphics and plotting ROM packs and processing and displaying complex waveforms becomes easier and faster. Because the commands are in machine language, they run much faster than the equivalent Basic programs.

The 4041R04 adds even more capabilities to the 4041. It is a general purpose ROM pack with the following capabilities:

- One line error messages
- Timers
- Loading Soft ROMs
- Using a ROM pack as a reading only storage device for fast program loading
- Listing ROM pack commands

**Test and Measurement Orientation**

The 4041 was developed to complement the TM 5000 line of programmable instruments. It follows Tektronix Standard Codes and Formats to allow easy communication with Tektronix instruments. 4041 Basic has high level commands to control GPIB instruments, allowing easy communication. For special cases the 4041 provides low level language commands for virtually complete control of the GPIB. The 4041 uses a powerful concept called stream specification. This allows a user to have virtually complete control of all the 4041s I/O devices.

Extensive error handling capabilities allow programs to recover gracefully from most errors, either operator or equipment. Errors can be trapped and execution of the program can be diverted to an error handling routine to allow recovery or if it is a nonrecoverable error, clean up the system before program shutdown. When the extensive I/O and error handling capabilities of the 4041 are combined with the self-diagnostic and error reporting feature of Tektronix programmable instruments an extremely effective combination results.

## CHARACTERISTICS

### FRONT PANEL KEYBOARD

### SYSTEM KEYS

**AUTO-LOAD** — Causes the internal magnetic tape to rewind and find the "AUTOLD" program. This program is then loaded into memory and execution begins.

**ABORT** — Halts program execution if no user-specified handler routine is called by the program. If a handler routine is specified for the ABORT key, program control is passed to that routine.

**PROCEED** — Performs one of the following functions depending on equipment or program state:

1. Causes program execution to start at the next program line if a Pause was encountered.
2. Resumes execution after an ABORT. If a program is loaded from the tape, execution starts from the first program line.
3. Delimits user input when requested from an Input statement.

**CLEAR** — Clears the alphanumeric display. Does not clear user-defined prompts or the input cursor from an INPUT statement.

**EEX** — Causes the number requested by an INPUT statement to be entered in scientific notation. Numbers entered after pressing the EEX (Enter Exponent) key are considered part of the exponent.

**PAUSE** — Halts the program after executing the current line. If the current program line is an INPUT statement, the program stops before the execution of INPUT.

### USER-DEFINABLE FUNCTION KEYS

Numeric user-definable function keys, 0-9, can be assigned subroutines by the applications program. The keys may be redefined by the program during execution to allow for unlimited user routines. The function keys can be enabled or disabled under the control of a program.

Numeric values are assigned to these keys for entering information requested by an INPUT statement. When input has been completed, user functions assigned to these keys are re-enabled.

The other two keys on the front-panel keyboard are the decimal key (".") and the minus ("−") key. The decimal key is provided for decimal point entry associated with numeric and the minus key is used to enter negative numbers associated with numeric.

Keyboard overlays may be used for labeling the function keys with a number or an abbreviation of the user routines.

### FRONT-PANEL DISPLAY

The front-panel display communicates test procedures and operator prompts and displays intermediate or final program results. The display is fully programmable.

### ALPHANUMERIC DISPLAY

**Alphanumeric Line** — Twenty characters.

**LED** — Sixteen segments.

**Size** — Height: 3.8 mm (0.15 in). Width: 2.8 mm (0.11 in).

**Characters Per Cm** — 1.6 characters/cm (4 characters/in).

**Character Symbols** — 64

**Message Viewing Time** — Programmable.

**Scrolling Rate** — Programmable.

### SYSTEM INDICATORS

**LEDS** — Located on the display front panel indicate the status of the system.

**BUSY** — Indicates that a program is running. A blinking BUSY light indicates that the system has PAUSED (temporarily halted).

**POWER** — Indicates the machine is on.

**I/O** — Indicates that an Input/Output operation is being performed.

**FN** — Indicates that the user-definable function keys are enabled.

## MAGNETIC TAPE DRIVE

Magnetic tape drive is used to store user's programs and data. The tape is the primary means of loading programs, particularly for execute-only applications; in addition, the tape drive provides for long-term unattended data logging.

**File Structure** — 48 named files (maximum).

**Capacity (Physical Records)** — 650 typical (600 minimum).

**Physical Record** — 256 bytes (typical tape capacity is 166,400 bytes).

**Average Transfer Rate** — 13,324 bits/s.

**Search Speed** — 1520 mm/s (60 in/s).

**Tape Rewind** — 1520 mm/s (60 in/s).

**Tape Cartridge** — 100A Certified Data Cartridge from Tektronix.

## PRINTER

The printer produces hard copies of the intermediate or final program results, operator prompts, and changes in variables or system status. Messages longer than 20 characters are printed on succeeding lines where the user can specify the appropriate indentation for better delineation and readability.

**Printing Method** — Thermal, fixed head.

**Capacity** — 20-character alphanumeric line.

**Font** — 5 x 7 dot matrix printed.

**Character Size** — 2.5 mm high x 1.8 mm wide (0.10 in high x 0.07 in wide).

**Line Spacing** — 4.23 mm (6 lines/in).

**Printing Speed** — 2.0 lines/s.

**Feed Speed** — 8.46 mm/s (0.34 in/s).

**Character Set** —
26 Uppercase letters
26 Lowercase letters
10 Numeric digits
34 Special characters
32 Control characters
128 Total

**Paper Size** — 60 mm x 25 m (2.36 in x 82 ft).

## CONTROLLING THE BUS

When using BASIC high level print and input commands, the 4041 automatically controls all bus management signals in the proper sequence for the desired interface task and instrument interaction. A bus management function program that uses direct IEEE Standard 488 mnemonic commands to accommodate differences in implementation of GPIB on other equipment. Virtually all legal bus states can be programmed this way, which affords a high degree of flexibility for addressing various system applications.

## BUS INTERRUPTS

The 4041 has the ability to detect and respond to various types of interrupt conditions that can be generated on the GPIB. User-specified software handlers can be written to perform various tasks when these conditions occur. Interrupts can be programmably ENABLED or DISABLED.

**Interrupt Conditions**

| Mnemonic | Message |
|---|---|
| SRQ | Service Request |
| EOI | End or Identify |
| IFC | Interface Clear |
| DCL | Device Clear |
| TCT | Take Control |
| MTA | My Talk Address |
| MLA | My Listen Address |

## BUS COMMUNICATION

Interface and bus device addressing are programmable. This allows the user to direct message and data flow to and/or from the appropriate interface and GPIB peripheral. Information such as primary and secondary addressing, along with pertinent device-dependent information, can be attached to a specific Logical Unit number. Subsequent communication with that GPIB device can be directed to the Logical Unit, eliminating the need for redundant or repetitious statement programming.

## TRANSFER RATES (IEEE STANDARD 488)

**Transfer Rates for the Standard Interface**

| | Input | Output |
|---|---|---|
| Normal Mode | Exceeds 5 kbytes/s | Exceeds 5 kbytes/s |
| Fast Mode | Exceeds 16.5 kbytes/s | Exceeds 19.5 kbytes/s |

## SERIAL INTERFACE

The 4041 comes with a standard serial asynchronous RS-232C interface. The 4041 can support applications requiring terminals, modem/host communication, or instrumentation with this interface protocol.

In addition to standard transmission rates from 75 to 9600 baud, transmission rates are programmable to any integer ranging from 2 to 9600 baud.

**Full Duplex** — Full capability (half duplex not supported).

**Transmit/Receive** — Matched rate only.

**Bits Per Character** — 5, 6, 7, or 8 bits.

**Stop Bits** — 1 or 2.

**Parity** — Even, Odd, High, Low, None.

## ERROR AND INTERRUPTS

Conditions such as parity, framing and overrun errors can all be programmably captured. User routines or handlers can then direct what action should be taken, depending on the particular condition.

The end of message delimiter (EOM) can be programmed to any one or two character ASCII string. This enables the 4041 to communicate with most hosts or peripherals via the serial interface.

## CLOCK/TIMER

One clock provides date and time of day which is programmably set. The timer clock returns the time in seconds since power up. The timer has 10 millisecond resolution.

## SELF TEST

An integral part of the 4041 is the self-test feature, which assures the user of reliable operation. Self-test is executed automatically on power-up and performs extensive hardware and operating system tests.

## DYNAMIC RANGE

**Short Floating Point** — Maximum ±3.40282 E+38; Minimum ±2.93874 E−39.

**Long Floating Point** — Maximum ±1.7976931348623 E+308; Minimum ±5.562684646269 E−309.

**Integer** — −32768 to +32767.

**Character String Length (Maximum)** — 32767.

**Array Elements (Real, Integer or Character Arrays)** — 32767 elements maximum per row (or column); limited by total memory installed.

## AC POWER REQUIREMENTS

**Line Voltage** — 100 V ac to 120 V ac, 200 V ac to 240 V ac ±10%.

**Line Frequency** — 48 Hz to 66 Hz.

**Power Consumption** — 120 W (maximum).

## ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature** — Without Data Cartridge or Printer Paper: 0°C to +55°C (+32°F to +131°F). With Data Cartridge or Printer Paper: 0°C to +45°C (+32°F to +113°F).

**Storage Temperature** — Without Data Cartridge or Printer Paper: −40°C to +75°C (−40°F to +167°F).

**Humidity** — Relative noncondensing 0°C to +45°C (+32°F to +113°F) −20% to 80% condensing.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**EMC** — Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 213 | 8.5 |
| Height | 180 | 7.2 |
| Depth | 520 | 20.8 |
| **Weights** | **kg** | **lb** |
| Net | 7.8 | 17.3 |
| Net (with options) | 8.7 | 19.3 |

## ORDERING INFORMATION

**4041** System Controller **$4,950**

**Includes:** Power cord (161-0066-00); blank overlays for FP keyboard (334-4074-00); system verification tape (062-5828-03); blank DC 100 Tape Cartridge (119-1350-00); RS-232C male loop back connector (013-0198-00); roll of printer paper (006-3557-00); Controller (GPIB) Programming Guide (070-3917-00); operator manual (070-3917-01).

### OPTIONS

**Option 01** — Second GPIB and RS-232C ports. **+$1,200**

**Option 02** — TTL Interface (8 Bit Parallel Interface). **+$800**

**Option 03** — Disk Interface and RS-232C port. **+$1,000**

**Option 10** — Combination of 4041R01 through 4041R04 ROM Packs. **$1,500**

**Option 30** — Program Development ROMs and ROM Carrier. **+$995**

**Option 31** — Program Development Keyboard. **+$550**

### CONVERSION KITS

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 4041 to the left of a TM 5003. Order 040-0984-01 **$190**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 4041 to the right of a 7D20T. Order 016-0827-00 **$340**

### ROM PACKS

**4041R01** — Graphics ROM Pack. **$495**

**4041R02** — Plotting ROM Pack. **$495**

**4041R03** — Signal Processing ROM Pack. **$795**

**4041R04** — Utility ROM Pack. **$295**

**Accessory Package Kit** — For use with 4041R04's PROM file system. Order 020-0102-00 **$160**

**EPROM Kit** — For 4041R04. Order 020-0101-00 **$60**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.

**FIELD INSTALLED MODIFICATIONS**

| | |
|---|---|
| **4041F01** — Same as Option 01 | **$1,800** |
| **4041F02** — Same as Option 02 | **$1,000** |
| **4041F03** — Same as Option 03 | **$1,600** |
| **4041F30** — Same as Option 30 | **$995** |
| **4041F31** — Same as Option 31 | **$550** |

**Note:** Contact your local Tektronix sales engineer before ordering field memory additions.

**OPTIONAL ACCESSORIES**

**Blank ROM Carrier** — Order 013-0215-00 **$180**

## 4041DDU Disk Drive Unit

**Contains Hard Disk/Flexible Disk Drive**

**5¼ inch Winchester Disk Drive**

**10.6 Mbyte Hard Disk Formatted Capacity**

**5¼ inch High Capacity Flexible Disk Drive**

**320 kbyte Flexible Disk Formatted Capacity**

**Interface Directly to 4041 with Option 03**

**Benchtop, Rackmount or Stack with 4041**

The 4041DDU (Disk Drive Unit) package includes a 10.6 Mbyte hard disk drive and a 320 kbyte flexible disk drive which can be optionally rackmounted. The 4041DDU provides additional mass storage, operating efficiency, and flexibility for the 4041 System Controller equipped with Option 03 disk interface.

The 4041DDU provides local access to high volume mass storage that adds capacity for a large number of applications programs and a high degree of program flexibility. The high capacity Winchester hard disk lowers the cost per Mbyte and provides the level of local data storage and fast access time that interactive graphics, waveform processing or instrumentation systems require. The maximum number of directory entries defaults to 256 and can be expanded to a maximum of over 1,000 entries. Sealed drive heads provide improved reliability, environmental protection and reduced maintenance.

The 4041DDU can be used in conjunction with the 4041's DC100 tape drive or operate as the primary mass storage device for your instrument system controller. The flexible disk media is the standard 48 tracks per inch, double sided, and double density diskette. The 4041DDU is enclosed in a cabinet and contains two disk drives, a power supply, controller card, and interface hardware.

### CHARACTERISTICS

**Capacity** — Hard Disk: Formatted 10.6 Mbytes. Flexible Disk: Formatted 320 kbytes including directories.

**Recording Format** — 512 bytes/sector.

**Tracks** — (Flexible Disk only) 40 tracks per side, double-sided, 48 tracks per inch.

**Track Density** — Hard Disk: 17 sectors per track. Flexible Disk: 8 sectors per track.

**Interfacing** — Interfaces directly to the 4041 with Option 03 (disk interface and RS-232C) installed.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V ac to 132 V ac at 2 A. 180 V ac to 264 V ac at 1 A.

**Line Frequency** — 47 Hz to 63 Hz.

**Maximum Power Consumption** — 140 W, 510 BTU/hour.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 214.3 | 8.4 |
| Height | 195.3 | 7.7 |
| Depth | 539.8 | 21.3 |
| **Weight** | **kg** | **lb** |
| Net | 8.2 | 20.0 |

## ORDERING INFORMATION

**4041DDU** Disk Drive Unit **$2,995**

**Includes:** Power cable (161-0066-00); disk interface cable (012-1117-00); DDU checkout DC100 tape (062-8554-00); 5¼ flexible diskette (119-1870-00); instruction manual.

**CONVERSION KITS**

**Cabinet-to-Rackmount** — Slide-out assembly to rackmount a 4041DDU. Order 016-0806-00 **$330**

**Cabinet-to-Rackmount** — Slide-out assembly to rackmount a 4041 to the right of a 4041DDU. Order 016-0807-00 **$240**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**OPTIONAL ACCESSORIES**

**Diskettes** — Package of ten. Order 119-1583-01 **$55**

## TEK SPS BASIC

**Versatile Instrument Control**

**Powerful Signal Processing Operations**

**Full Graphics Capability**

**Flexible Peripheral Handling**

**Multi-Level Program and Instrument Tasking Control**

**Extensive Support and Documentation**

**Tek SPS BASIC is a comprehensive, general purpose programming language with numerous enhancements for instrument control, waveform processing, peripheral handling, and graphic display.**

Modular in design, it provides an optimum balance between flexibility, programming efficiency and computing power; yet retains the easy-to-learn, easy-to-use, easy-to-remember characteristics of traditional BASIC. This makes it an ideal tool for beginners as well as expert programmers.

TEK SPS BASIC runs on any Tektronix CP1100 Instrument Controller or any DEC PDP-11 minicomputer. It consists of a resident monitor and an expandable library that lets you configure a software system to meet your unique measurement needs.

TEK SPS BASIC requires a minimum system consisting of a controller with two hard-disk drives or two flexible-disk drives, and a terminal.

### Versatile Instrument Control

- High-level GPIB driver for easy interaction with GPIB-compatible instruments.
- Low-level GPIB driver to permit line-level access to all IEEE Standard 488 features as well as custom-tailored instrument communica- tions.
- Specialized drivers to control Tek's digitizing products.
- Specialized commands to process and log instrument data.
- BASIC extensions to let the user handle interrupts.

The high-level GPIB driver allows easier communication with Tektronix instruments. Information is sent in either ASCII or binary formats using simple commands. The driver does the line-toggling and address translation, enabling easy interaction with up to 14 instruments on each of (1 to 4) GPIB interfaces; 56 instruments maximum.

Though the high-level driver is not limited to Tektronix instruments, it can automatically translate codes and formats used by Tektronix to efficiently send data.

The low-level driver provides the capability to send and receive data one byte at a time, to toggle individual GPIB control lines, and to obtain detailed status information about the bus, the interface, or the instruments in the system. This driver gives fast, precise, complete GPIB control while saving controller memory space.

When an instrument chooses to use its asynchronous interrupt capability to send a signal to the controller, TEK SPS BASIC gives the user complete control over the response. Using the high-level GPIB driver, the user can simply direct program control to specific subroutines while the driver handles the GPIB housekeeping.

Plus, raw data transformation from Tek's digitizing instruments is done quickly and easily with specialized commands. Other commands permit fast logging and averaging of waveform data.

**Powerful Signal Processing**

- Single-command array and waveform manipulation.
- Powerful mathematical transformations including Fourier analysis.
- String processing capability.

TEK SPS BASIC goes beyond what other programming languages offer in waveform processing convenience. A simple command, "get", accesses waveform array data from our digitizer, complete with sampling intervals, horizontal, and vertical scaling factors.

The waveform created can then be used in arithmetic expressions, and the scaling factors will be automatically updated to reflect the operations performed on the waveform.

The operations available for waveform arrays include standard arithmetic operators (+, −, ×, ÷) as well as the trigonometric, logarithm, and exponential functions. In addition, TEK SPS BASIC features array functions for providing minimum, maximum, RMS, size, and mean values, plus the time at which a waveform crosses a user specified threshold.

The package includes commonly used mathematical transformations such as integration, differentiation, Fast Fourier transforms (direct and inverse), convolution, and correlation. For a more detailed waveform analysis, subarray processing is also possible. With this capability, any specified portion of an array can be accessed with the same convenience as full arrays.

**Full Graphics Capability**

- Single command waveform displays and X-Y plots.
- Seventeen commands for personalized graphics.
- Graphic input.
- Variety of Tektronix graphic peripherals

Usually, processing software stops where graphics begin. Once again, TEK SPS BASIC helps you significantly with its capability to generate comprehensive, easy to create graphic displays. A single command displays your waveforms with graticule and scale factors in conventional formats. You can also position your graph anywhere on the screen, select tic marks, and generate waveforms with selected symbols.

In addition, TEK SPS BASIC offers the capability of identifying a point on the screen which can then be transferred to your program.

Graphics are not restricted to waveform or array display. Point to point line drawings enable you to generate any kind of representation you may want; bar charts, pie charts, three dimensional functions.

Hard copy units are available for all Tektronix graphic terminals. See page 76.

**Flexible Peripheral Handling**

- Variety of compatible peripherals.
- Device independent communication protocol.
- Random and sequential access files.
- Direct access data-logging from instruments.
- File compatible with DEC RT-11 operating system.

TEK SPS BASIC communication is fast and easy, with a complete choice of peripherals including graphic and alphanumeric terminals, floppy disk, hard disks, cassette and magnetic tapes, paper tape reader and punch, and line printers. Its peripheral interfacing code is written to be device independent. Hardware can be updated without program modification.

Simple commands exist for creating, labeling, listing, modifying, copying, writing into or reading from files. Formats are selectable, so you can extend this compatibility to the hardware or software of you choice. Random-access files are also a standard feature of TEK SPS BASIC, allowing you to easily access selected portions of a file.

**Multilevel Program and Instrument Control**

- Control of execution and scheduling of routines.
- Multi-tasking for error tracking.
- User-specified error-handling.
- Support for user-written BASIC drivers including interrupt processing.

TEK SPS BASIC offers numerous advanced features for those who need to push beyond the limits of conventional high-level language programming.

For instance, you have complete access to the mechanism used to decide which routines to execute. Organized into a "ready job" queue, a "current job" packet and a "suspended job" stack, this mechanism, "The Scheduler", makes sure that system resources are given to the most important routine ready to run at any given time.

BASIC commands permit you to enter routines into the "ready job" queue at a given time, after a given time, or on occurrence of a real-time event. Other commands or keywords allow you to assign a priority to each routine. Programming can be setup to automatically invoke control tasks, such as scans and self-check, while responding to asynchronous real-time events, such as instrument interrupts.

The Scheduler also stops all routines affected by a fatal error. You can control the impact of errors by linking together associated routines and assigning them a common task number.

Features normally accessible only through assembly-language level programming are offered by TEK SPS BASIC through the optional high-level support package. Memory addresses can be individually examined and changed; individual bits and bit patterns can be set, cleared, or tested; variables can be located in memory and manipulated at the bit level; values can be read or written in octal or hexadecimal as well as decimal representations. All these sophisticated operations are available in BASIC's "easy to learn, easy to use" format.

The high-level support package also offers an interrupt vector driver, which lets the programmer invoke special routines to handle instrument interrupts. This capability is particularly valuable in development of user-written instrument drivers.

In addition, BASIC offers many special commands and capabilities for custom-tailored programs. Using immediate mode commands new program lines can be entered during execution of a program. Typed input can be accepted and held until needed, or the keyboard can be "locked".

### Software Maintenance

Customers receive a periodic newsletter containing programming hints and responses to user questions. Many system errors can be corrected by customer-applied "patches." These short code sequences are published in the newsletter with instructions for adding them to established systems. Specific problems which appear to be possible software defects, may be addressed by submitting a Software Performance Report (SPR) which will be responded to in writing. (Category B support.)

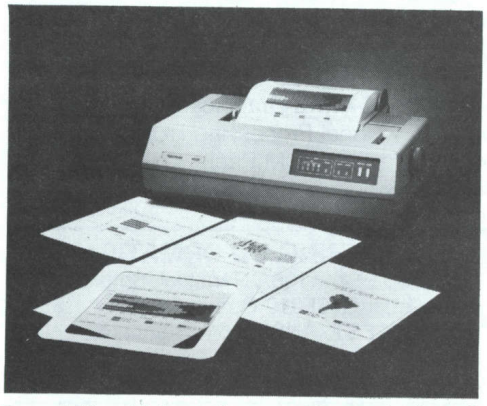
New packaged TEK SPS BASIC V03XM is configured for the DEC MICRO/PDP-11 and contains the following: Monitor, Signal Processing Module, Graphics Module, 7912AD Special Commands Module, 7612D Special Commands Module, GPIB High Level Driver Module, new disk driver, and line printer driver.

## ORDERING INFORMATION

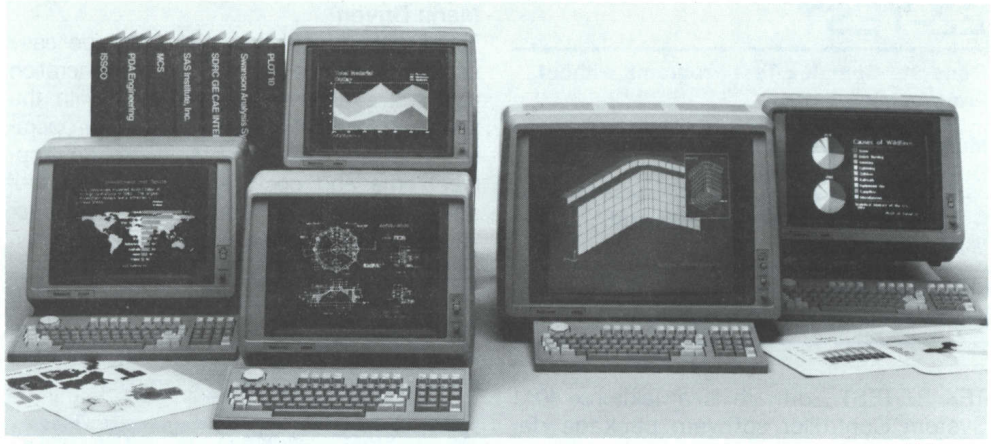
**SOFTWARE PACKAGES**

| | |
|---|---|
| **CP57000** TEK SPS BASIC (Monitor) | **$2,190** |
| **CP57001***1 Signal Processing | **$950** |
| **CP57002***1 Graphics | **$700** |
| **CP57003** R7912 Transient Digitizer Driver | **$950** |
| **CP57004** Digitizing Oscilloscope (DPO) Driver | **$500** |
| **CP57005** DPO Envelope Command | **$350** |
| **CP57006***1 7912AD Special Commands Driver | **$650** |
| **CP57007***1 High Level Support | **$350** |
| **CP57008** Assembly Level Support | **$1,000** |
| **CP57009***1 GPIB High Level Driver | **$500** |
| **CP57010***1 7612D Special Commands | **$300** |
| **CP57500***1 Extended Memory (V02XM) TEK SPS BASIC (Monitor) | **$3,190** |
| **CP575XX***1 Extended Memory Software (V02XM) are priced the same as V02 modules above, except for CP57500. | |
| **CP58000** (V03XM) TEK SPS BASIC Software for MICRO/PDP-11 | **$4,000** |

**1 Indicate modules included in V03XM CP58000.*



For additional information or a demonstration of the TEK SPS BASIC software family, call the Tektronix sales office in your area and ask for your sales engineer.



### 4100 SERIES TERMINALS SELECTION GUIDE

| | 4104A | 4105A | 4106A/ CX4106A | 4107A/ CX4107A | 4109A/ CX4109A |
|---|---|---|---|---|---|
| **Display Size** | 13-inch | 13-inch | 13-inch | 13-inch | 19-inch |
| **Color Palette** | 64 | 64 | 64 | 64 | 4096 |
| **Displayable Colors:** Graphics Alphanumeric | 4 4 | 8 8 | 16 8 | 16 8 | 16 8 |
| **Resolution** | 480 x 360 | 480 x 360 | 640 x 480 | 640 x 480 | 640 x 480 |
| **VT-100 compatible commands** | yes | yes | yes | yes | yes |
| **Expanded segment support** | no | no | yes | yes | yes |
| **Ability to draw arcs** | no | no | yes | yes | yes |
| **Pixel operations** | yes | yes | yes | yes | yes |
| **Two-way port communications** | no | no | yes | yes | yes |
| **Enhanced color copier support** | yes | yes | yes | yes | yes |
| **Fast monochrome copier support** | yes | yes | yes | yes | yes |
| **4958 Tablet support** | no | no | yes | yes | yes |
| **Option 21 memory** | no | no | no | yes | yes |
| **Prices Begin At** | $2,995 | $3,495 | $5,995/6,995 | $6,995/7,995 | $8,995/9,995 |

## 4695 Color Graphics Copier

**Unprecedented Image Quality in its Price Range**

**Clear Transparency Capability**

**Quiet, 20 Character/Second Printing**

**Small, Compact Package**

**Choice of Roll or Sheet Paper**

See page 76.

# TEK AUTOMATED PROGRAM DEVELOPMENT SOFTWARE

## EZ-TEST

**Generate Complex Test Programs without Programming Skills**

**Multilevel Menus Guide you Through Test Development Procedures**

**Color Graphics Plotting of Test and Waveform Data**

**Translates Generated Procedures into an Easily Modified BASIC Program**

TEK EZ-TEST Software is a Tektronix 4041 System Controller software package designed to help you produce automated test and measurement system programs quickly and easily, without computer programming skills.

With TEK EZ-TEST software, the 4041 learns your test procedure as you implement it manually through front panel instrument control. The software actually queries the instruments for the settings you have selected, and includes them in the program for recall and use during test execution.

TEK EZ-TEST software checks for instrument command errors as you develop your procedure and prevents you from entering incorrect settings. The software is comprised of two programs, a TPG (Test Procedure Generator) and a TRANSLATOR. The TPG is used to produce procedures using programmable test instruments physically attached to the IEEE Standard 488 Bus (GPIB). Once the procedure has been entered into the computer, it can be run and data results obtained. The procedure can be stored on tape as a data base and retrieved later for re-execution or modification by the TPG.

The TRANSLATOR program is used to convert the TPG procedure into actual 4041 BASIC code. This 4041 BASIC code is executable as a stand-alone program; faster, more efficient, more modifiable, and requiring less 4041 memory than the TPG program with its data base. Translated programs provide the flexibility required by most users who need to implement functions not provided by the TPG, such as special math functions to operate on acquired data, or acquire waveforms and operate on them via utilities from the Tektronix Instrumentation Software Library.

### Menu Driven

TEK EZ-TEST software menus provide easy access to all levels of procedure generation and test execution. All interaction with the system is through labeled user keys or operator keyboard entry. Your software development time and costs are greatly reduced, since there are no complicated codes or keywords to learn. If you need guidance when using TEK EZ-TEST software, a HELP key is included with each menu to provide detailed instructions on the use of the current menu keys. TEK EZ-TEST software menu selections are shown in the following examples.

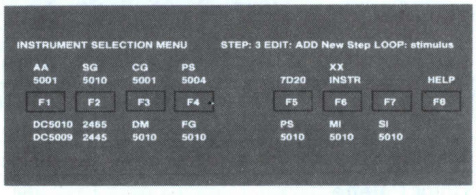



*Figure 1.*

The first step in developing a test procedure with TEK EZ-TEST, after selecting NEW STEP from the Edit menu, is to select the instrument to be used from the Instrument Selection Menu. In this example, the AA5001 Distortion Analyzer will be used.

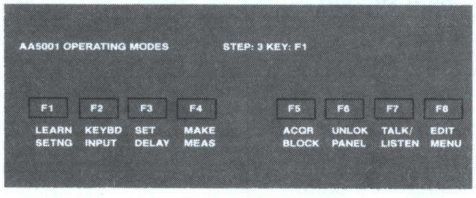



*Figure 2.*

Next, the user manually sets the controls on the front panel of the AA 5001 to the appropriate state. Then the "LEARN SETNG" (Learn Instrument Settings) key is pressed and TEK EZ-TEST acquires the AA 5001's settings. The AA 5001 will be used as the measurement device.

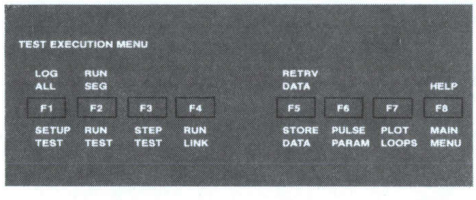



*Figure 3.*

Now TEK EZ-TEST is instructed to make 30 measurements. Above is shown the TEST EXECUTION MENU where "PLOT LOOPS" is selected to cause the data to be graphed.

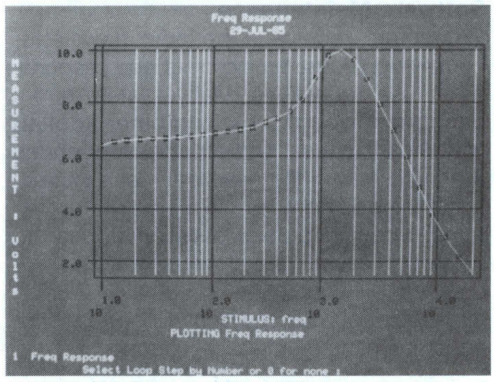



*Figure 4.*

The data is next plotted on a semi-log scale in figure 4 illustrating the frequency response characteristics of the selected signal. The data can be displayed in tabular form, directed to a line printer or stored on a mass storage device (tape, floppy disk, or hard disk).

### Instrument Support

A wide variety of IEEE Standard 488 programmable test and measurement instruments from Tektronix is supported. These include all TM 5000 modular instruments, 2400 Series portable scopes, 7D20, 390AD, and 7854 digitizing scopes, 490P Series spectrum analyzers, and DAS 9100 Series logic analyzers. TEK EZ-TEST software also supports most non-Tektronix IEEE Standard 488-1978 compatible instruments which use ASCII coded commands, and LF/EOI message termination. Up to 28 instruments can be supported with the 4041's Option 01 second GPIB port.

### Equipment Required

4041 System Controller
- Version 2.0 Firmware
- Option 25 — 160 kbytes memory (minimum)
- Option 30 — Program Development ROMS

RS-232C Terminal (recommended, or ANSI 3.64 compatible)

### Optional Hardware

Option 01 (4041) — Dual IEEE Standard 488 and RS-232C Ports
4041R01/4041R02 Graphics ROM Packs
4041R03 Signal Processing ROM Pack
4041R04 Utility ROM Pack
4695 Color Graphics Copier

### ORDERING INFORMATION

**TEK EZ-TEST** 4105A Terminal Software. Order S45F010 Option 04 **$500**

**TEK EZ-TEST** ANSI 3.64 Standard Terminal Software.
Order S45F020 Option 04 **$500**

# TEK GURU

GPIB User's Resource Utility
Menu-Driven Test Procedure Generator
Library of Commonly Used Subroutines
Graphics Capability
Flexible Peripheral Handling
Tutorial Manual
Instructional GPIB Programming Examples

TEK GURU (GPIB User's Resource Utility) is a low cost hardware/software package for instrument control, waveform acquisition and display. GURU supplies the important communications link between an IBM PC (or PC compatible) and GPIB instrumentation integrating the separate hardware units into a system designed to solve your application needs. GURU's software is written in IBM's Advanced BASIC (Microsoft's BASICA language) thus providing maximum flexibility to customize GURU for a specific application.

**Menu-Driven Test Procedure Generator**

GURU's Test Procedure Generator (TPG.BAS) is an excellent low cost tool for users who want fast results and do not want to learn to program their own test software. System users need only know which test instrumentation is required and which tests are required to be performed.

The TPG.BAS is best suited to nondigitizer applications where testing of devices is required using programmable power supplies, signal sources, digital voltmeters and frequency counters.

The TPG.BAS is a self-explanatory menu driven program (Figure 1).

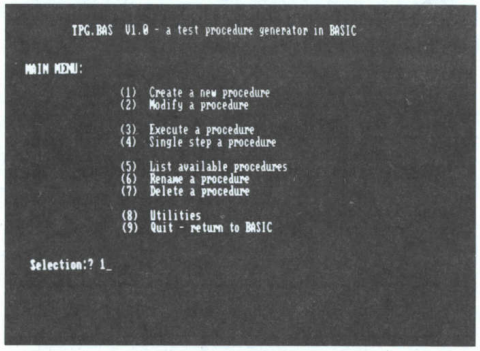



*Figure 1. To create a test procedure, enter the main menu and select an appropriate menu item. Pressing the "1" key selects "Creating a new procedure." The test equipment is then listed on the terminal screen and the user proceeds to the Function Menu (Figure 2).*

The Function Menu is the primary tool for developing a test procedure program. This menu contains all the important components of any test procedure.

Two other menus are also accessible from the Main Menu. A menu to modify a procedure (add, delete or replace individual steps), and a utility menu (enable, display or summarize the error log and to list the error log or current procedure to the printer).

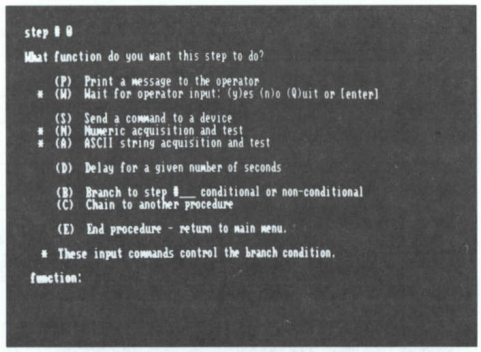



*Figure 2. Pressing the "W" key adds "wait for operator input" message step to the test procedure. GURU automatically asks for the required parameters at each procedure step.*

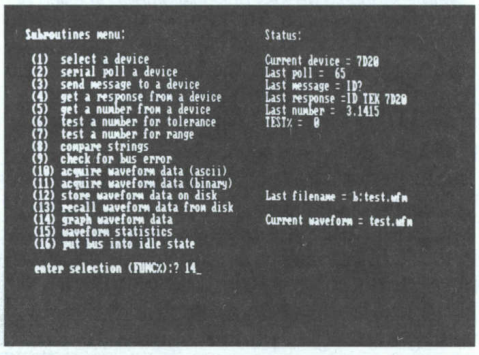



*Figure 3. Users appreciate the speed with which an application program can be built using the subroutine library.*

**Library of Commonly Used Subroutines**

This library (Figure 3) contains subroutines to do low level communications with GPIB devices, store/recall waveforms on a floppy disk, calculate waveform parameters and graph the waveform on the terminal. They are written in assembly language to facilitate maximum performance when sending or receiving commands or data. Waveform acquisition performance is further enhanced by the DMA transfer of waveforms to the controller's memory.

Figure 4 shows a sinewave captured and displayed by a GPIB controlled 7D20 Programmable Waveform Digitizer. The waveform may be also sent to a printer and notations added before printing.

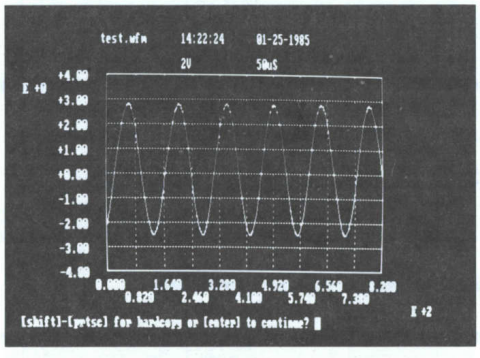



*Figure 4. To plot a waveform, select number 14 from the Subroutines Menu, (with prompts for vertical and horizontal scaling). Waveform data is automatically graphed on the terminal screen.*

**Tutorial Manual**

The GURU user manual is a well organized, clearly written, concise document and an extremely valuable GPIB reference.

It includes many examples of GPIB programs, which are very valuable when interfacing to various types of new GPIB instrumentation.

**Required Software**

IBM PC DOS 2.0/2.1/3.0 or higher with Advanced BASIC (BASICA), or

MS-DOS 2.0x/2.1x or higher with Advanced BASIC (BASICA)

**Optional Hardware**

1. Multifunction card with clock/calendar, serial/parallel ports and up to 384 k RAM, such as the AST SixPak Plus or QUADRAM Quadboard, or
2. I/O and clock calendar card such as the AST I/O Plus II with serial/parallel ports and clock calendar functions.

**Printers Supported**

IBM Graphics Printer or equivalent Epson, RX, FX Family, Toshiba P1340/P1350 Series. For the Toshiba P1340/P1350 Series only, GURU requires the Paper Screen utility from M.A.P. Systems, Inc., to obtain printer copies of screen graphics.

**Required Hardware**

GURU runs on an IBM PC, XT, Portable PC, PC AT (or compatible) and the members of the COMPAQ computer family.

Minimum Requirements—128 k memory, 1 DSDD floppy disk drive, parallel or serial port for printer.

GURU also requires either graphics/display card combination 1 or 2, listed below:

1. IBM Color/Graphics Adaptor (or compatible card) and the IBM Color Display (Model 5153 or equivalent such as the Princeton Graphics Systems HX-12) or a composite video monitor (color or monochrome).
2. Hercules Graphics Card (or equivalent) and IBM Monochrome Display (Model 5151 or equivalent, such as the Amdek 310/310A). Also required, for the Hercules Graphics Card only: GRAPH X utility from Hercules Computer Technology, to obtain printer copies of screen graphics.

**Additional Hardware Requirements for 062-8369-00**

Choose one of the following: National Instruments Interfaces, GPIB-PC, GPIB-PC2, GPIB-PC2A, or IBM PC GPIB adaptor.

## ORDERING INFORMATION

**062-8369-00** GURU Software and Documentation only package **$395**

**Includes:** GURU user's manual (070-5543-00) GURU software.

**021-0396-00** GURU Hardware/Software Package **$595**

**Includes:** In addition to the above, a GPIB cable (012-0991-00) and a GPIB interface board.

# DIGITIZERS

## CONTENTS


**2430** Portable Digital Storage Oscilloscope ..307
**2220** Portable Digital Storage Oscilloscope ..310
**2230** Portable Digital Storage Oscilloscope ..311
**336** Portable Digital Storage Oscilloscope ... 313
**7D20/7D20T** Programmable Digitizers ..... 315
**7854** Waveform Processing Oscilloscope .... 318
**7612D** Programmable Waveform Digitizer ... 321
**7A16P** Programmable Amplifier ..... 323
**7912AD** Programmable Waveform Digitizer ..324
**7B90P** Programmable Time Base ..... 325
**390AD** Programmable Waveform Digitizer ... 326
**5223** Digital Storage Oscilloscope ..... 328
**5B25N** Digital Time Base ..... 329


## IEEE STANDARD 488 COMPATIBLE

This section brings together high performance digitizing mainframes, stand-alone digitizers and portable digital storage oscilloscopes designed for precise automatic waveform measurements in demanding applications in R&D and production environments.

### Digital Storage

Digital storage utilizes a digitizing and reconstruction process. "Digitizing" consists of "sampling" and "quantizing." Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC). How often digitizing occurs is determined by the time base which uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. This rate is the digitizing rate (or sampling rate). Once the data is in the digital memory, it can be read out and reconstructed for displaying or further waveform processing.

The high performance digitizing mainframes offer a wide choice of performance capabilities to capture high or low speed signals that are repetitive or single shot. Configure mainframes to your needs from a choice of plug-ins. The 7854 combines outstanding analog and digital performance with microprocessor-based waveform processing whereas the 7612D and 7912AD combine, outstanding analog and digital performance with full programmability. The 7D20T incorporates a 7D20 into its own power module but without a display. The 7D20T is the ideal high performance digitizer in automated systems applications where visual display of the acquired signals is not required.

SONY/TEKTRONIX offers two portable digitizers, the 390AD and 336. The 390AD features dual-channel and dual-time-base operation. The 336 displays both analog and digitized waveforms simultaneously and can store up to 16 digitized waveforms for recall and display. It is microprocessor controlled and incorporates alphanumeric CRT readouts of the scale factors and cursor positions.

The 5223 Digitizing Oscilloscope is capable of displaying real time and stored waveforms simultaneously and accesses the digital storage functions by using the 5B25N Time Base.

The *NEW* 2230 and 2220 each feature 4 K record lengths, 100 ns peak detection, and optional GPIB or RS-232C interfaces. The *NEW* 2430 brings the best features of the industry standard 2400 Series into a digital storage oscilloscope. Tek's new patented feature "Save on Delta" provides unattended pass/fail testing.

### DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS

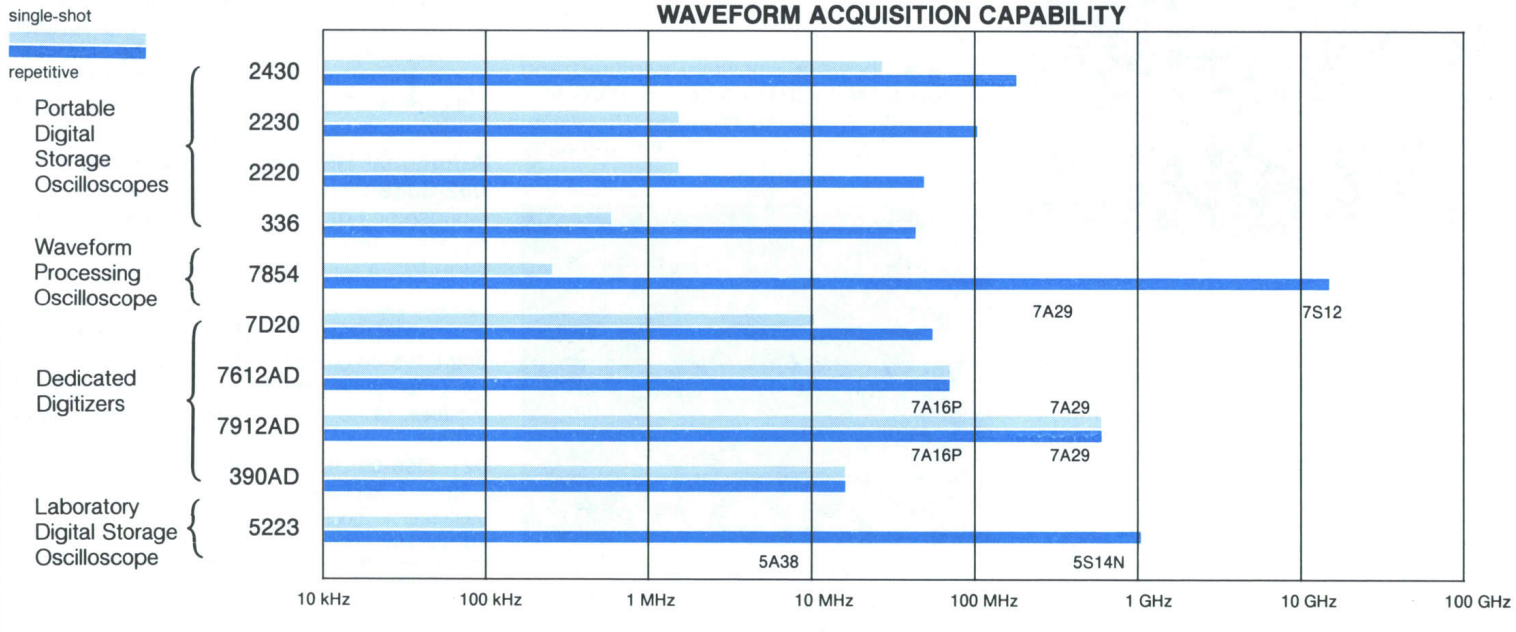
| Type | Analog Digitizing BW | Maximum Digitizing Rate | Vertical Resolution | Data Words Per Waveform | Maximum Stored Waveforms | Useful*1 Storage BW (SS) | Equiv*2 Storage BW (rep) |
|---|---|---|---|---|---|---|---|
| 5223 | 10 MHz | 1 MHz | 10 Bits | 1016/plug-in | 2 to 4 | 100 kHz | 10 MHz |
| 336 | 50 MHz | 1 MHz | 8 Bits | 1024 each channel | 2 (16 with option) | 100 kHz | 50 MHz |
| 2220 | 60 MHz | 20 MHz | 8 Bits | 2048 dual channel 4096 single channel | 2 | 2 MHz | 60 MHz |
| 2230 | 100 MHz | 20 MHz | 8 Bits | 2048 dual channel 4096 single channel | 8 (52 with option) | 2 MHz | 100 MHz |
| 7854 | 400 MHz*3 | 500 kHz Ext Clock | 10 Bits | Up to 1024 | Up to 40 | 50 kHz | 400 MHz |
| 7D20/ 7D20T | 70 MHz | 40 MHz | 8 Bits | Up to 1024 | 6 | 10 MHz | 70 MHz |
| 2430 | 150 MHz | 100 MHz | 8 Bits | 1024 | 6 | 40 MHz | 150 MHz |
| 390AD | 15 MHz | 30 MHz dual channel 60 MHz CH 1 | 10 Bits | 2048 dual channel 4096 CH 1 only | 2 | 15 MHz | 15 MHz |
| 7612D | 80 MHz | 200 MHz | 8 Bits | Up to 2048 | 2 to 16 | 80 MHz | 80 MHz |
| 7912AD | 500 MHz | 100 GHz | 9 Bits | 512 | 1 | 500 MHz | 500 MHz |

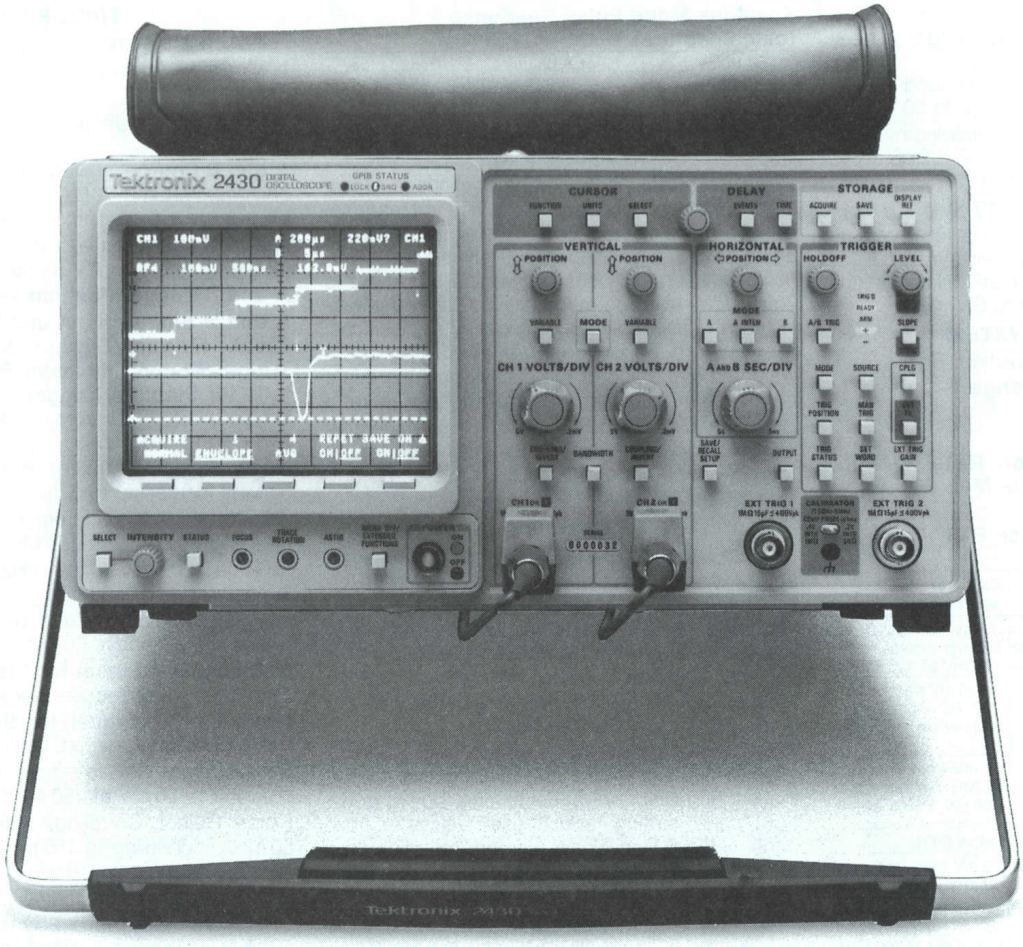
**1 Useful Storage Bandwidth is a measure of the highest frequency sinewave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.*

**2 Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent time digitizing techniques.*

**3 14 GHz with sampling.*

### WAVEFORM ACQUISITION CAPABILITY






## 2430 Digital Oscilloscope

GPIB IEEE-488

The 2430 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**150 MHz Bandwidth at Probe Tip**

**5 ns/div Sweep Speed**

**100 MS/s Sample Rate**

**Simultaneous Acquisition of Two Channels**

**Envelope Mode with 2 ns Glitch Capture**

**8 Bit Resolution Over 10 Divisions**

**Save on Delta (Tek Patented Feature) Provides Unattended Pass/Fail Testing and Babysitting Against a User Defined Reference or Envelope**

**Extensive Trigger Capability such as Delay by Time, Delay By Events, Two External Trigger Inputs Provide Flexibility for Use in TTL, ECL, and Analog Circuit Applications**

**Save up to Six Waveforms for Later Display, Analysis and Comparison**

**Full Screen Readout and Extensive Cursor Functions for Easy Operation and Measurements**

**Fully GPIB Programmable for Systems and Automated Test Applications**

**Three Year Warranty—Five Years Optional**

### Power and Flexibility in an Easy-To-Use Portable Digital Oscilloscope

With the *NEW* Tek 2430 we've brought the best features of our industry standard 2400 Series into the digital world. Capture complex wideband signals for TTL, ECL, and analog research, design and test.

The 2430 has a 150 MHz bandwidth, 5 ns/div maximum sweep speed, a digitizing rate of 100 Megasamples/sec with 8 bit resolution, and dual channel simultaneous acquisition. With its advanced feature set, the 2430 can meet your general purpose measurement needs while offering the advantages of a digitized waveform—including long term storage for future reference, data transfer, and waveform analysis—making the 2430 a powerful systems component.

Features of the 2430 include: 1024 point per channel record length; Average Mode for increased resolution and noise reduction on repetitive signals; Envelope Mode providing a unique ability to capture events as fast as 2 ns at any sweep rate; Save on Delta to capture and save events that deviate from user selected limits; Delay by Time and Delay by Events for detailed examination of complex waveforms.

With on screen readout, cursor functions, and front panel layout similar to other Tek 2400 Series instruments, the 2430 provides an easy to use tool. With its single level menu format and powerful measurement features, the 2430 will become the keystone of your instrumentation needs.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Bandwidth —** Dc: to 150 MHz (−3 dB). Ac: <10 Hz to 150 MHz.

**Bandwidth Limit —** 20 MHz and 50 MHz; selectable (reduces −3 dB point to between 13 MHz to 24 MHz and 45 MHz to 55 MHz respectively).

**Channels —** Two with simultaneous acquisition.

**Vertical Accuracy —** ±2% + 1 DL (DL = digitizing level. 25 DL's per division).

**Deflection Factor —** 2 mV to 5 V in 1-2-5 sequence, continuously variable between ranges.

**Auto Scale Factor —** Probe tip deflection factors for 1X, 10X, 100X, and 1000X indicated by on-screen readout. Scale factor available over GPIB Bus. Probe identification available via on-screen readout.

**Delay Matching —** ±250 ps.

**Channel Isolation —** 100:1 or greater attenuation of the deselected channel at 100 MHz, 50:1 or greater at 150 MHz for a 10 div input signal from 2 mV/div with equal VOLTS/DIV switch settings on both channels.

# TEK 150 MHz DUAL TRACE DIGITAL STORAGE OSCILLOSCOPE

**Maximum Input Voltage —**
1 MΩ: Dc, Ac, GND Coupled: 400 V (dc + peak ac) 800 V p-p ac at 10 kHz or less.
50 Ω: 5 V rms; 0.5 W sec for any 1 second interval for instantaneous voltages from 5 V to 50 V.

**Input R and C —** 1 MΩ ±0.5% paralleled by 15 pF ±2 pF. 50Ω ±1% paralleled by 15 pF ±2 pF.

**VSWR —** ≤1.3:1 (Dc to 150 MHz).

**Vertical Postion Range —** ±10 div (± ⅓ div).

**CMRR —** At least 10:1 at 50 MHz for common-mode signals of 10 div or less, with VAR VOLTS/DIV adjusted for best CMRR at 50 kHz at any VOLTS/DIV setting from 5 mV to 5 V.

## HORIZONTAL SYSTEM

**Display Modes —** A, A Intensified, B.

**A and B Delayed Sweep Range —** 5 ns/div to 5 s/div in 1-2-5 sequence.

**Accuracy —** 0.1%.

**External Clock Repetition Rate —** Min: 1 MHz. Max: 100 MHz. Events Max Rep Rate: 100 MHz.

**Signal Levels Required for EXT Clock or Events —**

| Coupling | CH 1 or CH 2 Source | EXT 1 or EXT 2 Source Gain=1 |
|---|---|---|
| Dc | 0.70 div from dc to 20 MHz increasing to 2.0 div at 100 MHz 3.0 div at 100 MHz in ADD mode | 35 mV from dc to 20 MHz increasing to 100 mV at 100 MHz |
| Noise Rej | ≥2.4 div from dc to 20 MHz; increasing to 6.0 div at 100 MHz. 9.0 div at 100 MHz in ADD mode. | ≥120 mV from dc to 20 MHz; increasing to 300 mV at 100 MHz |
| Ac | 0.7 div from 60 Hz to 20 MHz; increasing to 2.0 div at 100 MHz; 3.0 div at 100 MHz in ADD mode. Attenuates signals below 60 Hz. | 35 mV from 60 Hz to 20 MHz; increasing to 100 mV at 100 MHz; Attenuates signals below 60 Hz. |
| HF Rej | 2.0 div from dc to 30 kHz. Attenuates signals above 30 kHz. | 50 mV from dc to 30 kHz. |
| LF Rej | 2.0 div from 60 kHz to 20 MHz; increasing to 4.0 div at 100 MHz; 3.0 div at 100 MHz in ADD mode. Attenuates signals below 80 kHz. | 50 mV from 80 kHz to 20 MHz; increasing to 100 mV at 100 MHz. |

*Signal Levels Required for EXT clock or EVENTS; GAIN=÷5: Amplitudes are 5 times those specified for Ext. Gain=1.*

**Delay By Time and Delta Delay —** On screen readout will display time delay between measured events.

**Delay By Time and Delta Delay Maximum Delay —** (0.04 x B sec/div) to (65,536 x 0.04 B sec/div).

**Delay Time Resolution —** The greater of (0.04 x B sec/div) or 20 ns.

**Delay By Events —** Delays the A or B sweep by a user selected number of B trigger events after the normal A trigger occurs. On screen readout indicates number of events selected. the maximum number of events selectable is 65,536 with one event resolution.

## ACQUISITION SYSTEM

**Maximum Single Event Useful Storage Bandwidth —** 40 MHz (using internal Modified Sine X/X interpolator).

**Maximum Sample Rate —** 10 MS/s on two simultaneous channels.

**Vertical Resolution —** 8 bits (1 to 256 over 10.24 vertical div).

**Record Length —** 1024 points per channel.

## ACQUISITION MODES

**Normal Mode —** Repetitive and nonrepetitive acquisitions.

**Envelope Mode —** Records and displays minimum and maximum waveform values over 1 or more sweeps. Number of waveforms recorded before reset is user selectable in binary sequence from 1 to 256 or continuous.

**Envelope Mode Pulse Response (glitch capture) —**

| Pulse Duration | % of Amplitude Capture | Confidence Level |
|---|---|---|
| 2 ns | 50% | >85% |
| 4 ns | 50% | 100% |
| 8 ns | >90% | 100% |

**Average Mode —** Averages continuously for a number of acquisition from 2 to 256 in binary sequence (user selectable from front panel). Averaging of 256 acquisition effectively increases vertical resolution to 11 bits and vertical sensitivity to 200 μV/div. Average mode will do Stable Averaging for the user selected number of acquisitions, then switch to Exponential averaging for a weighted averaging of the display until there is a control change or other reset of the instrument.

**Save on Delta Mode —** Incoming waveforms will be compared against a user definable waveform envelope and SAVED if the waveform is outside reference limits.

## MEMORY

**Save Memory —** 8 k of waveform memory available. 4 display waveforms (1 k each), and 4 Reference waveforms (1 k each). Reference memory number 4 is user selectable for waveform data storage or to store 4 user definable front panel settings. Capacitive backed waveform data retention time, from last power on, of more than 120 hours at 26 C, 24 hours at 50 C.

**Nonvolatile Memory —** Approximately 2 k of memory containing calibration data, readout information, an initial front panel setting, power down front panel setting, and 1 user definable front panel setting. Nonvolatile memory retention time of more than 3 years using a Lithium battery backup.

## DISPLAY

**Display Modes —** CH 1, CH 2, Invert, Add, Multiply, X/Y (CH 1 vs CH 2, Ref 1 vs Ref 2) Reference displays 1 through 4.

**Ground Reference Display —** A plus symbol (+) is displayed at left of screen, tracking ground location. If ground is located off screen, plus (+) remains at screen perimeter indicating off screen location.

**Trigger Reference Display —** A "T" symbol appears on waveform displays, tracking location of trigger. If trigger point is located off screen in any direction, "T" symbol remains on screen at perimeter.

**Waveform Expansion —** 10X vertical expansion of SAVED waveforms, in 1-2-5 sequence. 100X horizontal expansion of SAVED waveforms, in 1-2-5 sequence.

**Readout —** Readout characters are displayed on screen to indicate instrument's current vertical channel selection, input coupling and termination, volts/div, time base and sec/div, trigger level and trigger source configuration, as well as, menu selections, and cursor functions.

**Horizontal Expansion of Saved Waveforms —** Up to 100X expansion. Horizontal positioning of saved waveforms.

## ON SCREEN CURSORS

**Functions —** Volts, Time, Volts at Time, 1/Time, Slope. These settings can be selected for delta or absolute time/volts with reference to trigger point or ground respectively. Delta delay will make differential time measurements by utilizing dual delayed sweep.

**Units —** Volts, Percent, dB, in absolute or delta time, percent, degrees in absolute or delta slope, percent.

## TRIGGERING

Following is a summary of triggering functions.

**A Mode —** Auto Level, Auto/Roll, Normal, Single Sequence.

**B Mode —** Triggerable After Delay, Runs After Delay.

**A and B Source —** Vertical, CH 1, CH 2, Line (A only), Ext 1, Ext 2, A B (A sweep only), Word (17-bit word recognizer probe optional accessory).

**A and B Coupling —** Dc, Noise Reject, HF Reject, LF Reject, Ac, TV (option: A coupling only).

**A and B Trigger Position —** Pre>post.

**A and B Slope (±), A and B Level, External Clock, Manual Trigger, Variable Holdoff, Trigger Status, Minimum P-P Signal Amplitude for Stable A Trigger**

Dc Coupled: 35 div from dc to 50 MHz increasing to 1 div at 150 MHz.

Noise Reject Coupled: ≤1.2 div from dc to 50 MHz increasing to 3 div at 150 MHz.

Ac Coupled: 35 div from 60 Hz to 50 MHz increasing to 1.0 div at 150 MHz.

LF Reject: 0.5 div from 80 kHz to 50 MHz increasing to 1.0 div at 150 MHz.

HF Reject: 0.50 div from dc to 30 kHz. Attenuates signals above 30 kHz.

**Minimum P-P Signal for Stable B Trigger —** Two times those required for stable A trigger.

**Minimum P-P Signal for Stable Trigger for Ext 1 and Ext 2 —** Ext. Gain: 1.

Dc Coupled: 17.5 mV from dc to 50 MHz, increasing to 50 mV at 150 MHz.

Noise Reject Coupling: ≤60 mV from dc to 50 MHz, increasing to 150 mV at 150 MHz.

Ac Coupled: 17.5 mV from 60 Hz to 50 MHz, increasing to 50 mV at 150 MHz.

LF Reject Coupled: 25 mV from 80 kHz to 50 MHz, increasing to 50 mV at 150 MHz.

HF Reject Coupled: 25 mV from dc to 30 kHz.

Ext÷5: Amplitudes are five times those given for Ext Gain=1.

**Ext 1 and Ext 2 Inputs —**
Resistance: 1 MΩ ±1%.
Capacitance: 15 pF ±3 pF.
Maximum Input Voltage: 400 V (dc + peak ac), 800 V p-p ac at 10 kHz or less.

**Trigger Level Control Range —**
CH 1 and CH 2 Source: ±18 div x V/div.
Ext 1 and Ext 2 Source Gain = ÷1: ±0.9 V.
Ext 1 and Ext 2 Source Gain = ÷5: ±4.5 V.
A and B Trigger Position: (pre>post) ⅛ to ⅞ of acquisition record, user selectable in ⅛-¼-½-¾-⅞ sequence. User selectable in 32 sample intervals using GPIB.

## REAR PANEL OUTPUTS/INPUTS

**Output Voltage —** 20 mV/div ±10% into 1 MΩ. 10 mV/div ±10% into 50Ω. −3 dB bandwidth is dc to >50 MHz.

**A Trigger, Record Trigger, and Word Recognizer Output —**
Logic Polarity: Negative true trigger occurence indicated by a HI to LO transition.
Output Voltage HI: ≤400 μA load is 2.5 V to 3.5 V. 50Ω Load to Ground is ≤0.15 V.
Output Voltage LO: <4 mA Load is ≤0.5 V. 50Ω Load to Ground is ≤0.15 V.

**Direct Hard Copy Output —** Sends waveform data, cursor measurements, and instrument configuration over GPIB to a Hewlett Packard HP 2225A printer. In Save On Delta mode, when discrepancy is detected, send hard copy output and then reinitialize Save On Delta Mode.

**Plotter Output —**
X Output and Y Output: Output Resistance is 1 kΩ ± 10%.
Output Range/Scale Factors: Y is 390 mV/div.
X(Y-T) is 195 mV/div.
X(X-Y) is 390 mV/div.
Effective slew rate is <8 V/s.
**Penlift, SPST Relay —**
Contact to Ground:
Polarity is Menu selectable.
Maximum Applied Open-Circuit Voltage is ±25 V.
Maximum Closed-Circuit Resistance is ≤0.25 Ω.
Maximum Closed-Circuit Current is ≤0.25 A.

### AC POWER REQUIREMENTS

**Line Voltage Ranges —** 115 V: 90 V to 132 V. 230 V: 180 V to 250 V.
**Line Frequency —** 48 Hz to 440 Hz.
**Power Consumption —** Typical (standard instruments): 160 W (250 VA). Maximum (fully optioned instrument): 200 W (300 VA).

### GPIB PROGRAMMABILITY

Standard on all instruments. Full talk-listen modes available, control all front panel settings. Transmit and receive waveform data. Sixteen lines of prompting messages or computed results can be displayed on screen via GPIB (40 characters per line) using Tek Codes and Formats.
**Data Transfer Rate —** 140 kybtes per sec maximum typical in Fast Transmit Mode.
**IEEE Standard 488-1978 Interface Function Subsets Implemented —** SH1, AH1, T5, L3, SR1, RL1, DC1, DTØ, PPØ, CØ.

### ENVIRONMENTAL AND SAFETY

The 2430 meets the environmental requirements of MIL-T-28800C for Type III, Class 3, Style D equipment, with humidity and temperature requirements defined in paragraphs 3.9.2.2, 3.8.2.3, and 3.9.2.4.
**Ambient Temperature —** Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.
**Altitude —** Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 000 m (50,000 ft).
**Vibration —** Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held ten minutes at each major resonance, or if none existed, held ten minutes at 55 Hz (75 minutes total test time).
**Humidity —** Operating and Nonoperating: Stored at 95% relative humidity for five cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.
**Shock —** Operating and Nonoperating: 50 g's, half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.
**Drip Proof —** Front cover meets MIL-T-28800C paragraph 4.5.5.5.3.
**Safety —** Certified by CSA, Electronic Bulletin No. 556B and UL1244 and complies with IEC 348.

### PHYSICAL CHARACTERISTICS

| Dimensions | Cabinet mm | Cabinet in | Rackmount mm | Rackmount in |
|---|---|---|---|---|
| Width (with handle) | 330 | 13.0 | 483 | 19.0 |
| Height | | | 178 | 7.0 |
| (with feet & pouch) | 190 | 7.5 | | |
| (without feet & pouch) | 160 | 6.3 | | |
| Depth | | | 419 | 16.5 |
| (with front cover) | 479 | 18.9 | | |
| (with handle extended) | 550 | 21.7 | | |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | | | 4.0 | 8.8 |
| (w/ accessories & pouch) | 12.8 | 28.1 | | |
| (w/o accessories & pouch) | 10.9 | 23.9 | | |
| Shipping | 16.4 | 36 | | |

# Option 05

## TV Waveform Measurement System

GPIB IEEE-488 The Option 05 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**All of the High-Performance Characteristics of the Standard 2430 Oscilloscope Plus Television Waveform Assessment Capabilities**

**Selectable System-M and Nonsystem-M Protocols**

**Selectable Triggering on Any Line Within a Field, with Line-Number Readout**

**GPIB-Controllable Functions for Use in Automatic Measurement Systems**

**Compatible with Composite Video**

**Television Blanking-Level Clamp (Back-Porch)**

**Optimized Vertical Response Comparable to High-Performance Television Waveform Monitors**

## CHARACTERISTICS

The set of characteristics is the same as specified for the standard 2430 Oscilloscope and includes the following additions:

### VERTICAL SYSTEM (CHANNEL 1 AND CHANNEL 2)

**Frequency Response —** For Volts/Div switch settings between 5 mV and 0.2 V, with Var Volts/Div calibrated and using a five-division, 50 kHz reference signal from a 50 Ω system, with external 50 Ω termination on 1 MΩ input.

| Frequency Range | Frequency Response With Full BW | Frequency Response With BW Limiting |
|---|---|---|
| 50 kHz to 5 MHz | ±1% | +1%, −4% |
| >5 MHz to 10 MHz | +1%, −2% | — |
| >10 MHz to 30 MHz | +2%, −3% | — |

**Squarewave Flatness —** ±1%, 1% p-p for both 60 Hz and 15 kHz squarewaves, using a 0.1 V input with Volts/Div settings between 5 mV and 20 mV and using a 1.0 V input with Volts/Div setting of 50 mV. Setup with 1 MΩ dc input coupling, external 50 Ω termination, Var Volts/Div in calibrated and fast-rise input signal (risetime ≤1 ns). Exclude first 20 ns following step transition and exclude first 30 ns when 20 MHz BW LIMIT is set. For signals with risetimes ≤10 ns, add 2% p-p between 155 ns and 165 ns after step transition.
*Note: Although flatness and frequency response are verified using a 50 Ω system, similar performance can be expected when using 75 Ω systems.*
**Television Blanking-Level Clamp (Back-Porch) 60 Hz Rejection (Channel 2 Only) —** ≥18 dB at 60 Hz, with Volts/Div settings between 5 mV and 0.2 V, Var Volts/Div control set to calibrated and a six-division reference signal.
**Television Blanking-Level Clamp (Back-Porch) Reference —** Within 1.0 division of ground reference.

### TRIGGERING

**Sync Separation —** Stable sync separation from sync-positive or sync-negative compositive video on systems with 525 to 1280 lines per frame, 50 Hz or 60 Hz field rate, interlaced or non-interlaced scan.
**Trigger Modes —** LINES, FLD 1, FLD 2, AND ALT (FLD 1, FLD 2) coupling.
**Input Signal Amplitude for Stable Triggering Channel 1 and Channel 2 —** 2.0 division for composite video and 0.6 division for composite sync signals (dc + peak video-signal amplitude must be within 18 divisions of input ground reference).
**External 1 and External 2 —** 60 mV division for composite video and 30 mV division for composite sync signals (dc +peak video-signal amplitude must be within nine divisions of input ground reference).

## ORDERING INFORMATION

**2430** 150 MHz Digital Oscilloscope **$8,900**
**Includes:** Two P6131 10X 1.3 m probes with accessories (010-6131-11); snap accessory pouch (016-0692-00); ziploc accessory pouch (016-0537-00); 5 A, ACG/3AG, 250 V fuse (159-0014-00); blue plastic CRT filter, installed (378-0199-00); clear plastic CRT filter (378-0208-00); front cover (200-2742-00); user reference guide (070-5497-00); operator manual (070-4918-00); users GPIB interface guide (070-5705-00).

### OPTIONS

**Option 1R —** Configure oscilloscope for rackmount. **+$320**
**Option 05 —** TV Waveform Measurement System. **+$1,050**
**Includes:** Same as 2430 plus CCIR graticule CRT filter (378-0199-01); NTSC graticule CRT filter.
**Option 11 —** Probe Power. **+$165**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1 —** Universal Euro 220 V/16 A, 50 Hz.
**Option A2 —** UK 240 V/13 A, 50 Hz.
**Option A3 —** Australian 240 V/10 A, 50 Hz.
**Option A4 —** North American 240 V/15 A, 60 Hz.
**Option A5 —** Switzerland 220 V/10 A, 50 Hz.

### *WARRANTY-PLUS* SERVICE PLANS

SEE PAGE 457

**M1 —** (2430) 2 Calibrations **+$240**
**M2 —** (2430) 2 Years Service **+$340**
**M3 —** (2430) 2 Years Service and 4 Calibrations **+$785**
**M4 —** (2430) 5 Calibrations **+$610**
**M5 —** (2430) 9 Calibrations +2 Years Service **+$1,430**

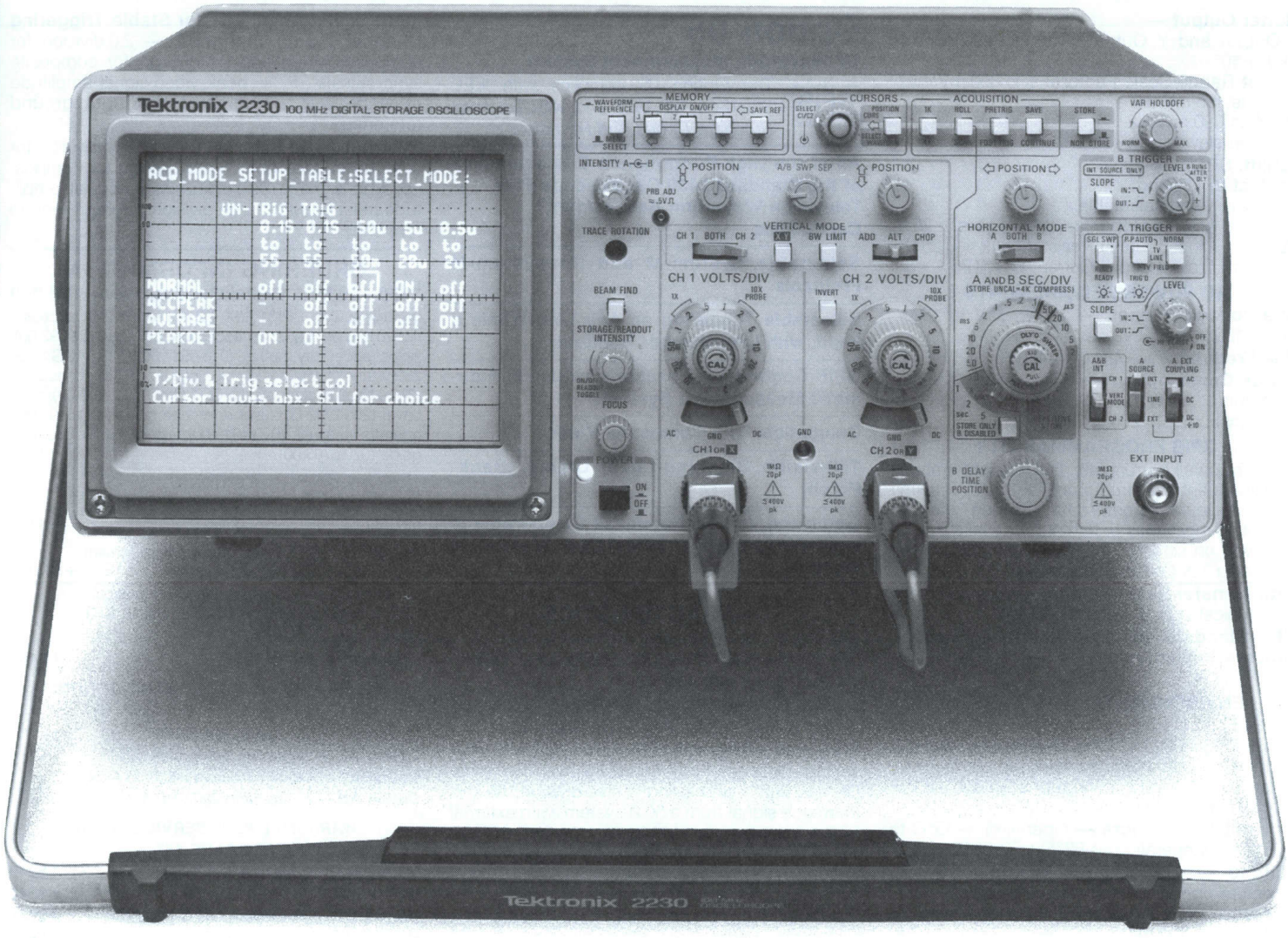
### OPTIONAL ACCESSORIES

**Rackmount Conversion Kit —** Order 016-0825-00 **$320**
**Word Recognizer Probe —** Order 010-6407-01. **$285**
**ECL Probe —** Order 010-6230-01 **$395**
**Protective Cover —** Blue vinyl. Order 016-0720-00 **$22**
**Carrying Strap —** Order 346-0058-00 **$15**
**Viewing Hoods —**
(Polarized, Collapsible) Order 016-0180-00 **$40**
(Folding, Light Shielding) Order 016-0592-00 **$13**
(Binocular, Collapsible) Order 016-0566-00 **$18.50**
**Camera —** C-30BP. See page 412

### RECOMMENDED CARTS

**K212 —** Portable Instrument Cart. See page 423 **$330**
**K117 —** Instrument Shuttle. See page 423 **$265**
**Service Manual —** Order 070-4917-00 **$30**
**Customer Training is available on this product. See page 452 for futher details.**

# TEK 100 MHz and 60 MHz DIGITAL STORAGE OSCILLOSCOPES




## 2230/2220

GPIB IEEE-488

The 2230 Option 10 and 2220 Option 10 comply with IEEE Standard 488-1978 and use Tektronix *Standard Codes and Formats*. The 2230 Option 12 and 2220 Option 12 features Standard RS-232-C and use Tektronix *Standard Codes and Formats*.

**100 MHz Digital Storage and Nonstorage (2230)**

**60 MHz Digital Storage and Nonstorage (2220)**

**Cursors for Time and Voltage Measurements (2230)**

**Signal Averaging**

**100 ns Glitch Capture**

**4 K Record Length**

**Post Acquisition Expansion, Compression, and Positioning**

**GPIB or RS-232-C Optional**

**26 K Battery-Backed Save Reference Memory (2230 Option 10 or 12)**

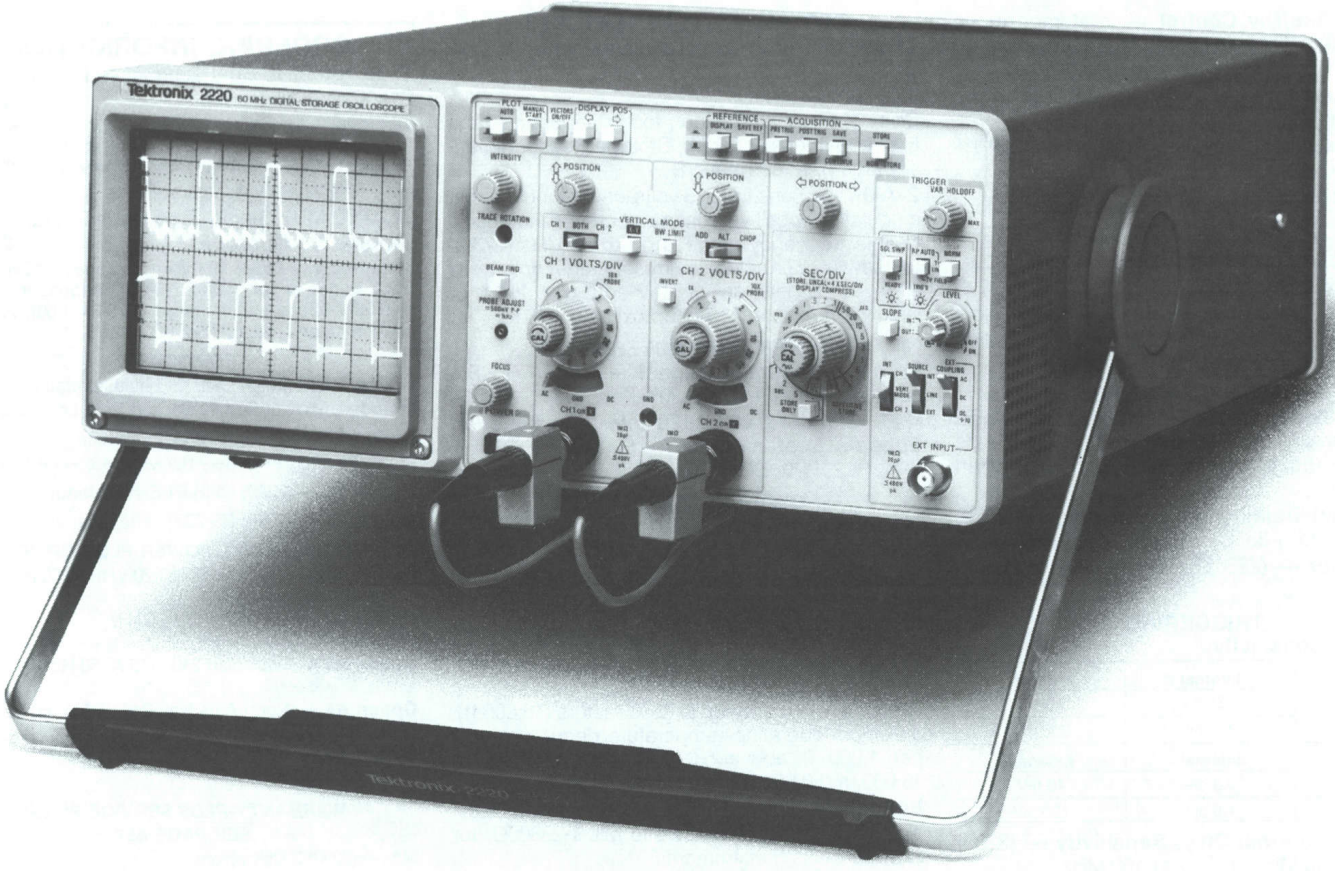
## TYPICAL APPLICATIONS

* **Digital Design and Troubleshooting**
* **Power Supply Design**
* **Electro-Mechanical**
* **Stress/Vibration Analysis**

The *NEW* Tektronix 2230 and 2220 are the answer for general purpose storage applications. These high perfomance portable scopes have storage and nonstorage bandwidths of 100 MHz (2230) and 60 MHz (2220).

These scopes are designed with many features which enhance their usefulness in your applications. The 2230 offers cursors and CRT readout enabling you to measure time or voltage differences easily and accurately. Save Reference memory allows you to view both stored and current waveform acquisitions on screen simultaneously. Signal averaging can be used to remove random noise from a signal and improve measurement accuracy.

100 ns glitch capture can be accomplished with the use of Peak Detect mode. This mode digitizes and stores, in acquisition memory as a data pair, the minimum and maximum levels of the input signal. The resulting display can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Unlimited storage time; expandable, compressible, repositionable stored traces; save reference memory; pre/post trigger viewing; roll mode; standard X-Y plotter output; and optional interfaces make the 2230 and 2220 the most sensible digital storage oscilloscopes to own.




## CHARACTERISTICS

The following characteristics are common to the 2230 and 2220 except where indicated.

### DIGITIZER AND MEMORY

**Speed** — Digitizing rates from 20 samples/s at 5 s/div to 20 MS/s at 5 μs/div and faster. Digitizing rate changes proportionate to sweep speed (100 data words/horizontal div) for sweep speeds of 5 s/div to 5 μs/div. CHOP/ALT modes effectively halves the digitizing rate/waveform. The effective sampling rate in Repetitive Storage mode is 2 GS/s.

**Useful Storage Bandwidth** — Single Shot: Dc to 2 MHz (single channel). Useful storage bandwidth is defined as the frequency where there are 10 samples per signal period at the maximum sampling rate. Repetitive Storage mode: Dc to 100 MHz (2230); Dc to 60 MHz (2220).

**Resolution** — Vertical: 8 bits, 25 levels per division. Horizontal: 10 bits.

**Acquisition/Process Modes** — Sample, Peak Detect, Accumulated Peak Detect, Average, Smoothing.

**External Clock** — Provides an input for EXT CLOCK signals, dc to 1 kHz, to the storage acquisition system.

**Peak Detect (Envelope) Mode** — 100 ns minimum pulse width for 100% probability of 50% signal amplitude capture. 10 MS/s sampling rate.

**Average Mode** — (2230) Normalized Average weight is selectable from 1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256. Number of sweeps averaged is adjustable from 1 to 2047 or the default condition of NO LIMIT can be selected. (2220) Average is active in Repetitive Storage mode only (2 μs to 0.05 μs/div). Normalized Average weight is 1/4.

**Pre/Post Trigger** — (2230) 7/8 (PRETRIG) or 1/8 (POSTTRIG) of waveform acquisition window prior to the trigger event. Trigger position is adjustable over the entire acquisition record by menu selection. (2220) PRETRIG: 7/8 of waveform acquisition window prior to the trigger event. POSTTRIG: 1/8 of waveform acquisition window prior to the trigger event. MIDTRIG: 1/2 of the waveform acquisition window prior to the trigger event.

**Record Length** — (2230) 4 K or 1 K record length selectable. (2220) 4 K record length.

**Save Reference Memory** — (2230) One 4 K or three 1 K acquisitions may be saved in reference memory. Options 10 and 12 offer 26 K of additional battery-backed reference memory. (2220) One 4 K acquisition may be saved in reference memory.

**Cursor Accuracy** — Voltage difference is within ±3% of the delta voltage readout value. Time difference is within ± [1 display interval (+1 display interval if in ACC PEAK or PEAK DETECT)] for sweep speeds of 5 μs to 5 s/div and within ± [2 display intervals + (2 display intervals if in ACC PEAK) +500 ps] for sweep speeds of 0.05 μs to 2 μs/div.

**X-Y Plotter Output** — Standard on both the 2230 and 2220.

### VERTICAL SYSTEM (2 Identical Channels)

**Bandwidth (−3 dB) and Risetime (Non-Store)** — (2230) 100 MHz and 3.5 ns, derated to 80 MHz and 4.4 ns at 2 mV/div and outside 0 °C to +35°C. (2220) 60 MHz and 5.8 ns, derated to 50 MHz and 7.0 ns at 2 mV/div and outside 0°C to +35°C.

**Bandwidth Limit** — (2230) 20 MHz ±10%. (2220) 10 MHz ±15%.

**Nonstore Deflection Factor and Accuracy** — 2 mV to 5 V/div 1-2-5 sequence, accuracy is ±2%. Accuracy derated to ±3% outside 0°C to +35°C. Uncalibrated: Continuously variable between steps to at least 2.5:1.

**Store Deflection Factor and Accuracy** — 2 mV to 5 V/div. Displayed signal amplitude is within ±3% of the true input voltage over the dynamic range of the A/D converter.

**Vertical System Operating Modes** — CH 1, CH 2, CH 2 Invert, ADD, ALT, CHOP, (500 kHz nonstore).

**Common-Mode Rejection Ratio** — For signals of 6 div or less, at least 10:1 (at 50 MHz).

**Input R and C** — 1 MΩ, 20 pF.

**Maximum Input Voltage (Ac and Dc Coupled)** — 400 V (Dc + peak Ac) or 800 V (p-p to 10 kHz).

**Channel 1/Channel 2 Isolation** — 100:1 at 50 MHz.

**Ac-Coupled Lower Cutoff Frequency** — 10 Hz or less at −3 dB.

**Automatic Scale Factor** — (2230) Probe tip deflection factors for coded probes are automatically indicated in the CRT readout.

### HORIZONTAL SYSTEM

**A Time Base** — 0.05 μs to 0.5 s/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div. In STORE mode, lower sweep speed is extended to 5 s/div.

**B Time Base (2230)** — 0.05 μs to 50 ms/div in 1-2-5 sequence. 10X magnifier extends the maximum sweep speed to 5 ns/div.

**Variable Sec/Div Control** — In storage mode has no effect. In Non-Storage mode, uncalibrated variable extends sweeps by at least 2.5:1.

**Sweep Linearity** — ±5% over any two of the center eight divisions.

**Time Base Accuracy** — Storage Mode: 0.1% over full 10 cm (or div).

**Nonstorage Mode**

| | +15°C to +35°C | 0 to +50°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

**Horizontal Operating Modes** — (2230) Nonstorage: A, Alternate with A intensified by B, and B; Storage: A, A intensified by B, and B.

## DELAYED SWEEP

**Delayed Sweep Delay Times** — (2230) Continuously variable with 10-turn control from less 0.5 divisions plus 300 ns to greater than 10 divisions.

**Differential Delay Time Accuracy** — (2230) ±1% (0°C to +35°C, ±2% (0°C to +50°C).

**Delay Jitter** — (2230) 5,000:1 (0.02%), nonstore mode only.

## TRIGGERING

**A Trigger Sensitivity**

| 2230 | Internal | External |
|---|---|---|
| 10 MHz | 0.35 div | 40 mV |
| 100 MHz | 1.5 div | 200 mV |
| **2220** | **Internal** | **External** |
| 5 MHz | 0.3 div | 40 mV |
| 60 MHz | 1.0 div | 120 mV |

**B Trigger (Internal Only) Sensitivity** — (2230) 0.35 div at 10 MHz, 1.5 div at 100 MHz.

**Trigger System Operating Modes** — Normal, P-P Automatic, TV Line, TV Field, and Single Sweep. HF REJ triggering attenuates signals above 40 kHz. Lowest useable frequency for P-P Automatic is 20 Hz.

**Trigger Coupling** — Automatic coupling with internal signal sources: Ac with P-P Automatic and TV Field; Dc with Normal and Single Sweep.

**Trigger Sources** — A trigger: internal, external, and line. B trigger (2230): internal only.

**External Trigger Input** — Input Coupling: Ac, dc, or dc divide by 10. Bandwidth: 100 MHz (2230), 60 MHz (2220); Ac-coupled lower cutoff frequency is 10 Hz or less at −3 dB. Maximum safe input voltage same as scope's vertical channels.

## X-Y MEASUREMENTS

**Deflection Factors** — Same as scope's vertical system with the Volts/Div switch in calibrated detent.

**Accuracy** — Storage Mode is same as digital storage vertical deflection system.

| 2230 Nonstorage | Y-Axis | X-Axis |
|---|---|---|
| +15°C to +35°C | ±2% | ±3% |
| 0°C to +50°C | ±3% | ±4% |

**Storage Mode Bandwidth** — (2230) dc to 100 MHz. (2220) dc to 60 MHz. Bandwidth changes proportionate to sweep speed.

**Nonstorage Bandwidth** — Y-axis same as scope's vertical system, X-axis: 3.0 MHz.

**Nonstorage Phase Difference** — Between X and Y amplifiers: ±3° from dc to 150 kHz.

**Storage Mode Phase Difference** — Time difference between Y-axis and X-axis is no more than 100 ns. The X-axis is sampled before the Y-axis. Between X and Y amplifiers: less than ±2° referenced to a 10 division signal period.

## CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 cm display; internal graticule, unilluminated, Accelerating potential is 14 kV, GH (P31) phosphor standard.

**Controls** — Beam finder, focus, separate A and B sweep intensity (2230), Storage/Readout intensity (2230), trace rotation.

**Z-Axis** — Sensitivity: 5 volts causes noticeable modulation, positive voltage decreases intensity. Usable frequency range is dc to 20 MHz (2230), to 10 MHz (2220). Maximum safe input voltage is 30 V (dc + peak ac) or 10 V ac p-p at 1 kHz or less. Input resistance is approximately 10 kΩ.

## OTHER CHARACTERISTICS

**Probe Adjustment Signal** — 0.5 V ± 5% square wave at 1 kHz ±20%.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L3, SR1, RL2, PPØ, DC1, CØ, DTØ.

## POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 85 W, 2.0 A, at 250 V (slow blow).

## ENVIRONMENTAL AND SAFETY

**Temperature** — Operating: 0°C to +50°C; Nonoperating: −55°C to +75°C.

**Altitude** — Operating: to 4500 meters (15,000 ft), maximum operating temperature decreased 1°C per 1,000 ft above 5,000 ft. Nonoperating: to 15 000 m (50,000 ft).

**Humidity** — Operating and Nonoperating: 5 cycles (120 hours) referenced to MIL-T-28800C, for Type III, Class 5 instruments.

**Radiated and Conducted Emission** — Requirements per VDE-0871. Meets Class B.

**Vibration** — Operating: 15 minutes along each of three axes at a total displacement of 0.015 inch p-p (2.4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one minute sweeps; hold for 10 minutes at 55 Hz in each axis; all major resonances must be above 55 Hz.

**Shock** — Operating and Nonoperating: 30 g's, half-sine, 11 ms duration, 3 shocks per axis for a total of 18 shocks.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width (with handle) | 360 | 14.2 |
| Width (without handle) | 237 | 9.3 |
| Height (with feet and handle) | 137 | 5.4 |
| Depth (with front cover) | 445 | 17.5 |
| Depth (without front cover) | 440 | 17.3 |
| Depth (with handle extended) | 511 | 20.1 |
| **Weight** | **kg** | **lb** |
| Net (without cover, accessories, and pouch) | 8.3 | 18.0 |

## GPIB IEEE-488 Option 10 GPIB Interface

Option 10 for both the 2230 and 2220 adds the ability to communicate over the General Purpose Interface Bus. The 2230 Option 10 also includes 26 K of battery backed reference memory.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SHI, AHI, T6, L3, SRI, R12, TPØ, DCI, DTØ, CØ, E2.

## Option 12 RS-232-C Interface

Option 12 for both the 2230 and 2220 adds RS-232-C Interface ability. The 2230 Option 12 also includes 26 K of battery backed reference memory.

## ORDERING INFORMATION

**2230** 100 MHz Dual Time Base Digital Storage Oscilloscope **$5,150**

**Includes:** Two P6121 10X voltage probes (010-6121-01), front panel cover (200-2520-00), accessory pouch (016-0677-02), operator manual (070-4998-00), 2230 user's reference card (070-5370-00).

**2220** 60 MHz Single Time Base Digital Storage Oscilloscope **$4,150**

**Includes:** Two P6122 10X voltage probes (010-6122-01), front panel cover (200-2520-00), accessory pouch (016-0677-02), operator manual (070-5301-00), 2220 user's reference card (070-5681-00).

### OPTIONS

**Option 10** — (2230) GPIB IEEE-488 Interface. **+$850**
**Includes:** 26 K of Battery-Backed Reference Memory.

**Option 12** — (2230) RS-232-C Interface **+$850**
**Includes:** 26 K of Battery-Backed Reference Memory.

**Option 10** — (2220) GPIB IEEE-488 Interface. **+$550**

**Option 12** — (2220) RS-232-C Interface. **+$550**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz. Order 020-0859-00.

**Option A2** — UK 240 V/13 A, 50 Hz. Order 020-0860-00.

**Option A3** — Australian 240 V/10 A, 50 Hz. Order 020-0862-00.

**Option A4** — North American 240 V/15 A, 60 Hz. Order 020-0862-00.

**Option A5** — Switzerland 220 V/10 A, 50 Hz. Order 020-0863-00.

### *WARRANTY-PLUS* SERVICE PLANS

SEE PAGE 457

**M1** — (2230) 2 Calibrations. **+$215**
**M1** — (2220) 2 Calibrations. **+$205**
**M2** — (2230) + 2 Years Service. **+$250**
**M2** — (2220) + 2 Years Service. **+$235**
**M3** — (2230) 4 Calibrations & 2 Years Service. **+$640**
**M3** — (2220) 4 Calibrations & 2 Years Service. **+$610**
**M4** — (2230) 5 Calibrations. **+$555**
**M4** — (2220) 5 Calibrations. **+$535**
**M5** — (2230) 9 Calibrations & 2 Years Service. **+$1,240**
**M5** — (2220) 9 Calibrations & 2 Years Service. **+$1,185**

### OPTIONAL ACCESSORIES

**2230 Service Manual** — Order 070-4999-00 **$25**

**2220 Service Manual** — Order 070-5302-00 **$25**

**Rackmount Adaptor Kit** — Order 016-1003-00 **$100**

**Carrying Strap** — Order 346-0199-00 **$17**

**Carrying Case** — Order 016-0792-01 **$340**

**Viewing Hood** —
(Binocular) Order 016-0677-02 **$42**
(Collapsible) Order 016-0592-00 **$13**
(Polarized) Order 016-0180-00 **$40**

**A6902B Isolator** — For floating measurements see page 437 for complete description.

**Current Probes** — A6302/AM503. See page 443.

**CRT Light Filter** — (Clear). Order 337-2775-01 **$1.95**

**1107 Mounting Kit** — Order 016-0785-00 **$50**

**Recommended Probes** — See page 426.

### RECOMMENDED CARTS

**K212** — Portable Instrument Cart **$330**

**K117** — Instrument Shuttle **$265**

### RECOMMENDED CAMERAS

**C-5C Option 04** — See page 416.

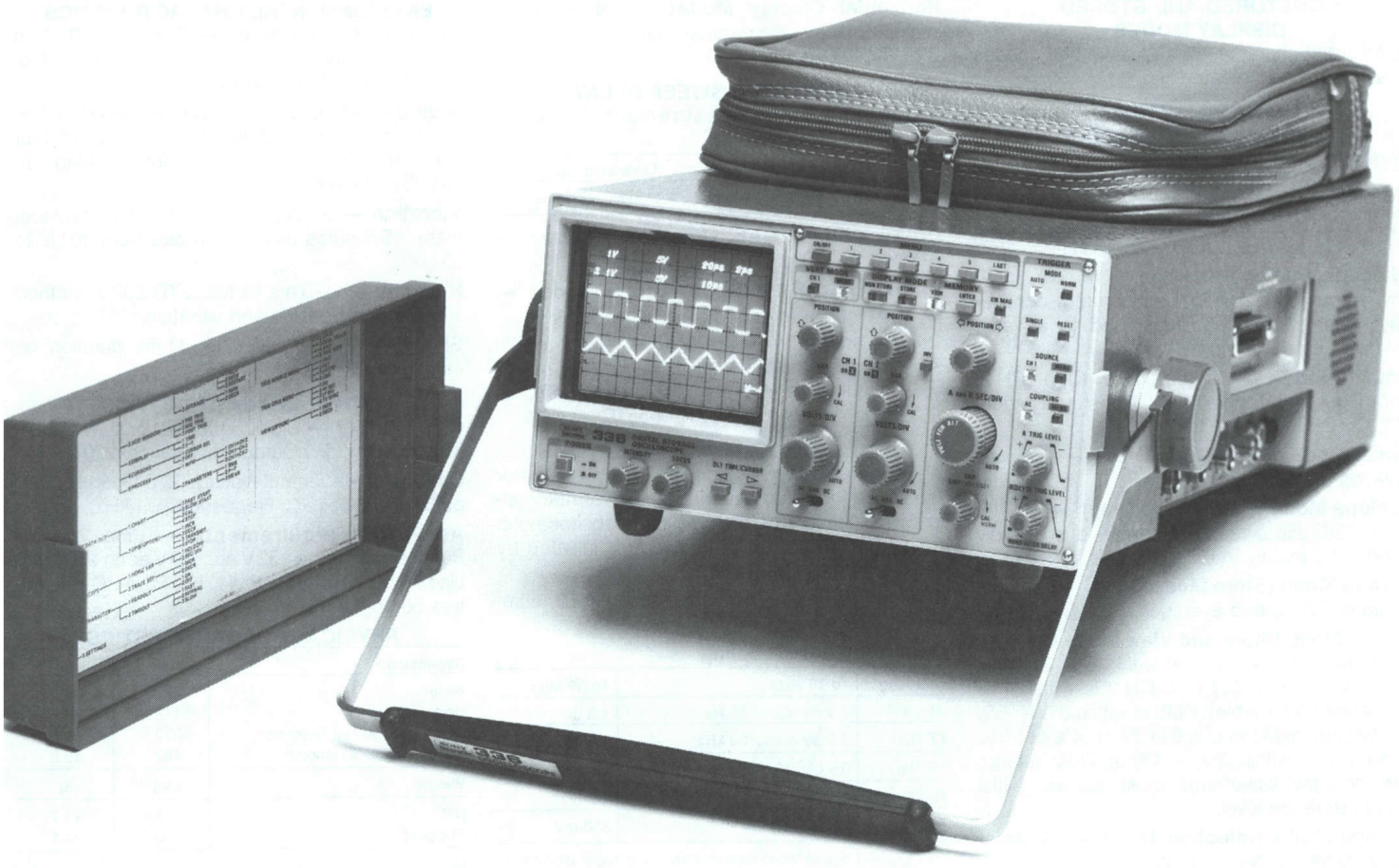
**C-7 Option 02** — See page 410.

**C-30BP** — See page 412.

**Customer Training is available on this product. See page 452 for further details.**



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



# 336

GPIB IEEE-488

The 336 with Option 01 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**1 MS/s, 140 kHz Useful Storage Bandwidth**

**Cursors for Time and Voltage Measurements**

**Signal Averaging**

**Envelope Mode**

**GPIB and 8 Screen Memory Option (16 k)**

**50 MHz Nonstorage Bandwidth**

**CRT Readout**

## TYPICAL APPLICATIONS

* **Medical Systems**
* **Communication Equipment Service**
* **Electronic Design**
* **X-Ray Equipment Maintenance**

The SONY/TEKTRONIX 336 is a combination nonstorage and digital storage portable oscilloscope. It is capable of displaying analog and digitized waveforms simultaneously, and can store up to 18 digitized waveforms for recall and display. The 336 is a microprocessor controlled instrument that incorporates alphanumeric CRT readouts of the vertical and horizontal scale factors, the delay time position, and voltage and time readouts of the cursor positions. Many of the oscilloscope features and modes are chosen from a menu displayed on the CRT rather than from hard-wired front-panel switches. Also included is an Auto mode for both vertical volts per division and horizontal time per division, allowing "hands off" operation in many applications.

The 336 has a dual-channel, dc-to-50 MHz vertical deflection system for both nonstorage and equivalent-time digitizing. Storage bandwidth for single sweep events (waveforms acquired as the result of a single triggering event) is dc-to-140 kHz. The vertical channels have calibrated deflection factors from 5 mV to 10 V per division with a choice of either ac or dc input coupling. In the Nonstore mode, the 336 operates like a conventional oscilloscope.

GPIB (talker only) is optional on the 336. Included in the option is a memory backup of up to eight screens (two 1 k waveforms each) of information.

## CHARACTERISTICS

### DIGITIZER AND MEMORY

**Speed** — Digitizing rates up to 1 megasample/s.

**Useful Storage Bandwidth** — Real Time Sampling: Dc to 140 kHz (−3 dB). Equivalent Time Sampling: Dc to 50 MHz (−3 dB).

**Resolution** — Vertical: Eight bit. Horizontal: Ten bit.

**Memory Size** — Standard: 2 kbyte (one frame of two waveforms). Option 01: 16 kbyte (up to eight frames of two 1 k waveforms each storage capacity). Data Retention: At least 3 days (after 8 hours of operation).

### VIEW DISPLAY MODE

This is the saved "store" waveform (saved from Store display mode). Process functions are the same as Store display mode.

## NONSTORED AND STORED DISPLAY MODES

The following characteristics apply to both modes unless otherwise indicated.

## VERTICAL SYSTEM (2 IDENTICAL CHANNELS)

**Bandwidth and Risetime*[1]**

| 0°C to +40°C | +40°C to +55°C |
|---|---|
| Dc to at least 50 MHz | Dc to at least 40 MHz |

*[1] *At all deflection factors from a 50 Ω source.*

**Deflection Factor** — Range: 5 mV/div to 10 V/div. Accuracy is ±3%. Uncalibrated, continuously variable between steps, and to at least 25 V/div.

**Vertical Modes** — Stored Mode: CH 1, CH 2, Chop, Dual and Trigger View. Nonstored Mode: CH 1, CH 2, Chop and Dual.

**Normal Mode (Store Mode Only)** — Acquired displayed signal.

**Envelope Mode (Store Mode Only)** — 1, 8, 16, 32, 64, 128, 256 sweeps, or continuous at s/div settings of 2 ms/div to 0.2 s/div.

**Average Mode (Store Mode Only)** — 8, 16, 32, 64, 128 or 256 sweep averages.

**Process Mode (Store and View Mode Only)** — Waveform: CH 1 + CH 2 is within 6%. CH 1 − CH 2 is within 6%. CH 1 × CH 2 is within 7%. Parameters (Selectable): RMS is within 3% + 6% of V/div setting. Mean is within 3% + 4% of V/div setting. P-p is within 3% + 4% of V/div setting. Store or view waveforms must acquire initial ground reference level.

**Common-Mode Rejection Ratio** — At least 10:1 at 10 MHz (5 MHz storage).

**Input R and C** — 1 MΩ ±2% paralleled by 33 pF.

**Maximum Input Voltage** — 200 V (dc + peak ac) or 200 V p-p ac to 1 kHz.

## HORIZONTAL SYSTEM (NONSTORE MODE ONLY)

**Time Base A** — 0.2 s/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div. (At sweep speeds slower than 0.2 s the scope automatically goes to Roll mode.)

**Time Base B** — 50 ms/div to 0.1 μs/div in a 1-2-5 sequence. X10 MAG extends the maximum sweep rate to 10 ns/div.

**Variable Time Control** — Continuously variable between calibrated settings of the A s/div switch. Extends the slowest sweep rate to at least 0.5 s/div.

**Time Base Accuracy**

| | +20°C to +30°C | 0°C to +55°C |
|---|---|---|
| Unmagnified | ±2% | ±3% |
| Magnified | ±3% | ±4% |

## DIGITAL STORAGE HORIZONTAL ACQUISITION

**Resolution** — Ten bit. 1024 data points.

**Range** — Equivalent Time Sampling: 50 ns/div to 0.1 ms/div. Single Sweep Storage: 0.2 s/div to 0.1 ms/div. Roll Mode: 20 s/div to 0.5 s/div. Envelope Mode: 0.2 s/div to 2 ms/div.

**Accuracy** — 3% from +20°C to +30°C; 4% from 0°C to +55°C.

**Horizontal Display Modes** — Nonstore: A sweep, B delay, alternate, X-Y. Storage: A sweep, B delay, X-Y.

## CALIBRATED SWEEP DELAY

**Differential Time Measurement Accuracy (Nonstore Mode)**

| | |
|---|---|
| +15°C to +35°C | within 1% of indicated value |
| 0°C to +55°C | within 2.5% of indicated value |

**Delay Time Jitter (Nonstore Mode)** — ≤1 part in 10,000.

**Delay Time Resolution (Store Mode)** — 14 bit.

**Cursor Accuracy (Store Mode)** — ΔV: Within 3%. ΔT: Real time sampling is ±0.1% of full scale. Equivalent time sampling from +20°C to +30°C is ±3%; from 0°C to +55°C is ±4%.

## TRIGGERING A AND B

**A Trigger Modes** — Normal: Sweep generator requires a trigger to generate a sweep. Automatic: Sweep generator free runs in the absence of a trigger. Single sweep: One sweep is initiated by the first trigger after reset.

**Trigger Sources** — Internal, CH 1, CH 2, composite or external.

**Sensitivity and Coupling**

| Coupling | To 10 MHz | To 50 MHz |
|---|---|---|
| AL | 0.3 div above 30 Hz | 1.5 div |
| LF Rej | 0.5 div above 50 kHz | 1.5 div |
| HF Rej | 0.5 div, 30 Hz to 50 kHz | —— |
| Dc | 0.3 div | 1.5 div |
| External | 70 mV | 350 mV |
| TV | Stable video rejection and sync separation from sync-negative NTSC or PAL composite video | |

**Trigger Jitter** — Nonstore Mode: 1 ns or less at 50 MHz. Storage Mode: ±1 sample period.

**External Trigger View** — Deflection Factor: Ext is 100 mV/div. Ext ÷ 10 is 1 V/div.

**External Trigger Input** — R and C = 1 MΩ paralleled by 33 pF (200 V dc + peak ac) maximum input.

**Acquisition Window Trigger Point** — Pretrigger: 7/8 of waveform occurs before trigger point. Midtrigger: 1/2 of waveform occurs before trigger point. Posttrigger: 1/8 of waveform occurs before trigger point.

## X-Y OPERATION (NONSTORE)

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div with bandwidth of dc to 1 MHz. Phase difference is 3° from dc to 50 kHz.

## CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 div (0.6 cm/div) display, GH (P31) phosphor. 12 kV operating potential.

**Graticule** — Internal. Vertical and horizontal centerlines marked in 5 minor div/major 0.6 cm/div.

**Z-Axis Input** — Range +3 V to +25 V with 1 MHz usable frequency range. Input resistance of at least 10 kΩ.

## ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: 0°C to +55°C. Nonoperating: −25°C to +75°C. Option 01: −20°C to +55°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Decrease maximum operating temperatures 1°C for each 1000 ft above 5000 ft. Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — 0.025 p-p (4 g's at 55 Hz) displacement, 15 minutes along each axis from 10 Hz to 55 Hz.

**Humidity** — 120 hrs of MIL STD 202D, method 106C, minus freezing and vibration.

**Shock** — 30 g's half sine, 11 ms duration on each axis.

## OTHER CHARACTERISTICS

**Chart Output** — Clock Rate: Fast or slow. Amplitude: 500 mV/div. Output Impedance: 220 Ω.

**Calibrator** — Output Voltage: 0.3 V ±1%. Output Resistance: 5 Ω. Frequency: ≈1 kHz.

**Ac Power Requirements** — Line Voltage Ranges: 90 V ac to 132 V ac, 180 V ac to 250 V ac. Line Frequency: 48 Hz to 440 Hz. Power Consumption: 50 W maximum.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 237 | 9.3 |
| Height | 112 | 4.4 |
| Depth (Handle Not Extended) | 370 | 14.6 |
| Depth (Handle Extended) | 482 | 19.0 |
| **Weight** | **kg** | **lb** |
| Net | 5.0 | 11.1 |
| Shipping | 10.5 | 23.1 |

## GPIB IEEE-488 Option 01

### GPIB Interface/Extended Memory

Option 01 provides a GPIB interface (talk only) and extended memory. The GPIB interface transfers waveforms and scale factor information to a listener or controller. 16 K total extended memory stores 16 additional waveforms at 2 waveforms per screen.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T1, LØ, SR1, RLØ, DC2, DTØ, PPØ, CØ.

## ORDERING INFORMATION

**336** Digital Storage Portable Oscilloscope **$4,960**

**Includes:** Two 10X P6148 Attenuator probes (010-6148-13); accessory pouch (016-0718-00); front panel cover (016-0719-00); CRT filter (378-0225-00); operator manual (070-4421-00) and service manual (070-4420-00).

**Option 01** — GPIB Interface/Extended Memory. **+$875**

### OPTIONAL ACCESSORIES

**Camera** — Order C-30BP Option 01 **$1,524**

**Camera Mounting Adaptor** — Order 016-0327-01 **$170**

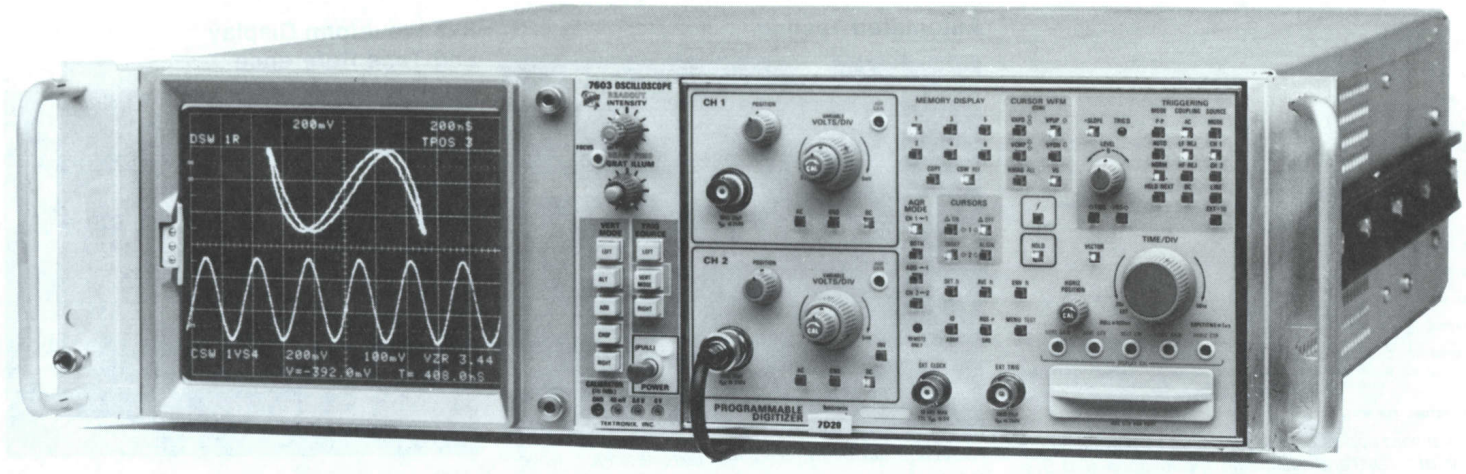
**Carts** — Order K212 or K117. See page 423 for complete description.

The SONY®/TEKTRONIX® 336 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 336 is available from Tektronix, Inc., its marketing subsidiaries and distributors.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99




*The 7D20 is used with 7000 Series oscilloscopes, such as the R7603, shown here, for rack installations. See pages 246 through 254 for details.*

# 7D20/7D20T

GPIB IEEE-488

The 7D20 and 7D20T comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Digital Storage for 7000 Series Mainframe (7D20)**

**70 MHz Bandwidth for Repetitive Signals**

**10 MHz Single-Shot Bandwidth**

**Two Channels Simultaneous Acquisition**

**Totally Programmable**

**Storage of Six Independent Waveforms**

**Enveloping and Signal Averaging**

**Cursor Measurements**

**Pretrigger and Posttrigger**

## TYPICAL APPLICATIONS

* **Ultrasonics**
* **Digital Design**
* **RF Modulation**
* **Automated Production Testing**

The 7D20 brings state-of-the-art digital performance to Tektronix 7000 Series mainframes and rackmounts.

The 7D20 is a GPIB programmable plug-in that is compatible with all 7000 Series mainframes (including the USM 281C) except the 7104. When combined with a 7000 Series mainframe, this plug-in creates a fully programmable, digitizing oscilloscope.

The 7D20T is the ideal high performance digitizer for automated systems applications not requiring a complete oscilloscope mainframe.

The 7D20T is supplied with its own power module, but without a display. Rear panel connectors provide X, Y, and Z output data for use with an external X-Y monitor.

Four feedthrough cables permit routing of input/output signals from the front panel of the 7D20T to the rear in rack-mounted applications. The GPIB cable may be connected to either the front or the rear of the 7D20T.

For those users who already own a 7D20 and would like to convert this 7000 Series plug-in into the 7D20T configuration, the power module itself is available as a 7D20T Option 01.

The capabilities and characteristics described for the 7D20 also apply to the 7D20T.

The 7D20 can accurately measure the amplitude of a 50 ns wide transient event. Dual samplers simultaneously acquire two channels as if it were a "dual-beam" scope.

Beyond basic acquisition, the 7D20 offers signal averaging to reduce uncorrelated noise, envelope displays to compare dynamic characteristics of changing signals, pretrigger for viewing prior to the trigger event, storage of six independent waveforms plus a reference waveform, cursors for more accurate two-dot measurements, and user prompting and menu displays to improve user interface effectiveness.

### Digital Storage

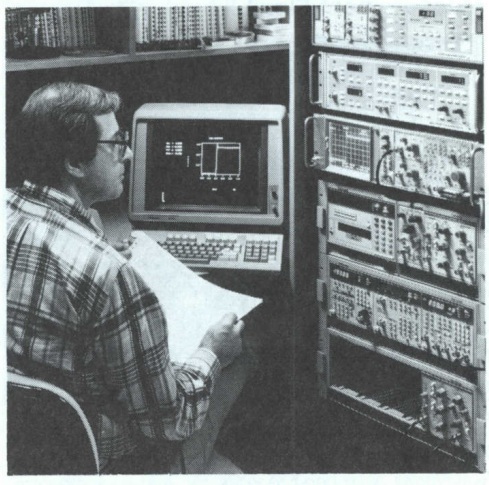
A 40 MHz maximum sampling rate provides approximately 10 MHz single-shot bandwidth and up to 70 MHz bandwidth with repetitive signals.

### Storage and Recall Front Panel Settings

Up to six different front panel set-ups can be stored and recalled as desired. These settings, plus the last panel setup, are saved in nonvolatile memory and are restored automatically when power is applied.

### Fully Automated Measurements

Since the 7D20 is completely programmable, fully automated measurement and testing is possible. Tektronix programmable signal sources, multi-function interface, and RF scanner provide and control the test signals while the 7D20 acquires waveforms for the computer or controller.



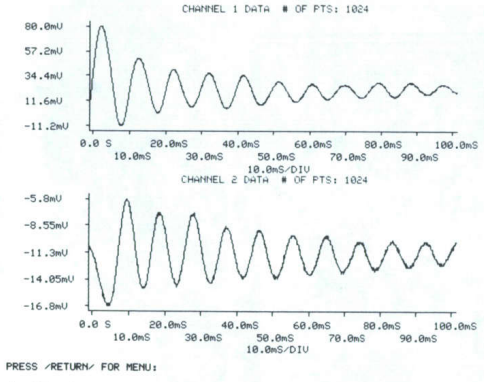
*The 7D20 is ideal for system applications of all sorts and supports many levels of automation, from menu driven to fully automated.*

### TekMAP Software Support

Tektronix Measurement and Application Programs (TekMAP) help you to tap the full potential of the 7D20. The 7D20/Tek 4041 software package supports the 7D20 when used in conjunction with the Tek 4041 Controller. It provides automated pulse parameter analysis and storage and retrieval of waveforms on DC-100 tape. Data results are available in graphic or tabular form.

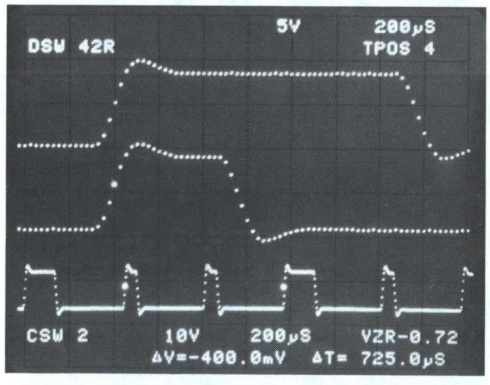
The 7D20/HP Series 200 software package supports the 7D20 when used with the HP Series 200 (216, 226, 236) Technical Computers. It provides automated pulse parameter analysis, propagation delay measurements, FFT, and storage and retrieval of front panel settings and waveforms. Data results are available in graphic or tabular form.

Additional TekMAP products will be available early 1986. Contact your local sales office for information.




*Archival hard copies can be produced by a system consisting of a 7D20 and mainframe, the Tektronix 4041 System Controller, 4105A Computer Display Terminal, and the 4695 Color Graphics Copier.*

## Measurement Flexibility

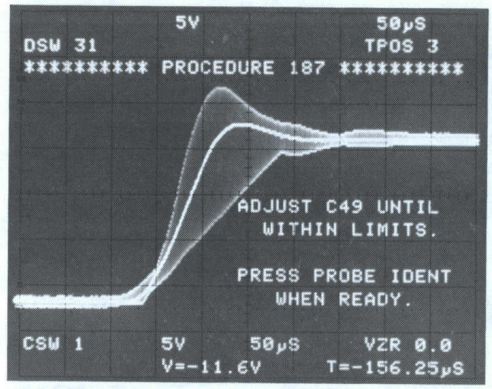



*View and compare two different portions of the same waveform or of two different waveforms. All of these waveforms have been repositioned and vertically compressed. The two upper waveforms, two pulses from a single pulse train, are magnified portions of the lowest waveforms. The time (ΔT) between the two cursors indicates the time between the leading edges of two pulses in the pulse train.*

## Hands Off Operation With Probe Identify Feature

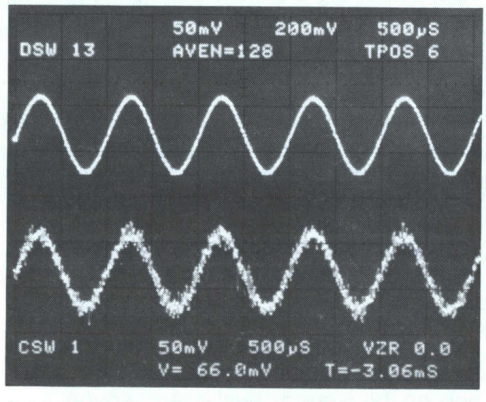
Recommended for use in interactive, computer-coordinated tasks, the Tektronix P6053B Probe allows computer routines to be sequentially activated at the 7D20's probe tip. This probe's "Identify" button signals the GPIB Interface via an input channel coded request. This capability allows the operator to work at a short distance from the 7D20 without the need to touch front panel controls. Two such probes may be used, one for each vertical channel.

## Automated Testing



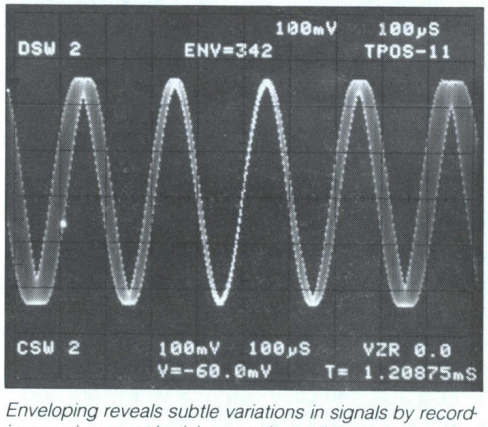

*For interactive test procedures, text messages, waveforms, and front panel set-ups may be transmitted and received from the 7D20 to a controller or computer. The procedure in this display informs the operator of the next task. Upper and lower tolerance limits are displayed as a single envelope. This envelope was initially constructed using the 7D20's envelope feature while a test signal was varied to its allowable limits. The waveform was then transferred and saved by the controller to serve as the test reference or overlay.*

## Signal Averaging



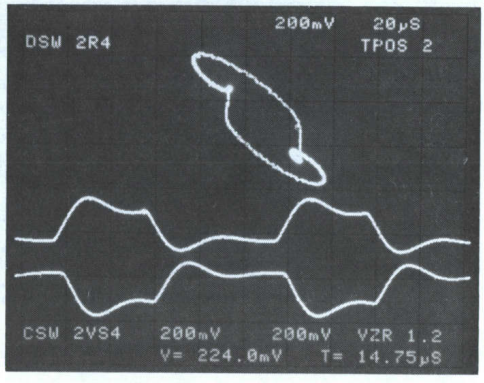

*Averaging reduces uncorrelated noise to improve measurement accuracy and display quality. Continuous and self-terminating averaging are provided. The self-terminating averaging processes a fixed number (N) of waveforms and then holds the result in memory. The N value is selectable from 8 to 256 in powers of 2. The top waveform in this display is the result of averaging the bottom waveform 128 times.*

## Enveloping




*Enveloping reveals subtle variations in signals by recording maximum and minimum values of recurring sweeps while vectors "paint" in the envelope. The effects of frequency shift are dramatically displayed.*

## X-Y Waveform Display and Time Reference

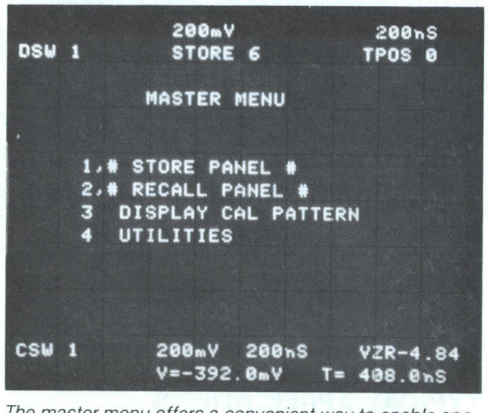



*Unique display capability allows viewing Y versus X events and Y versus time simultaneously. X-Y channels are matched at 10 MHz with <2° of phase shift.*

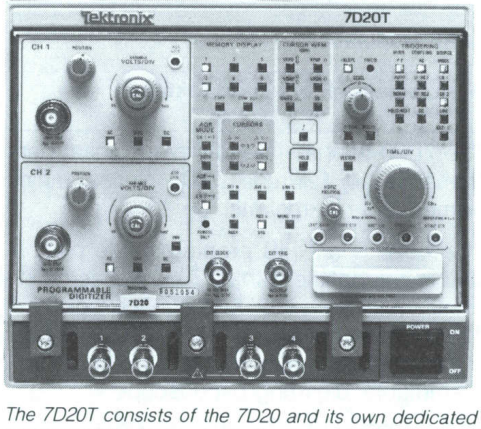
## Cursor Measurements

Accurate amplitude measurements (referenced to ground) and time measurements (referenced to trigger position) are made using one cursor. Point-to-point difference (Δ) measurements are made using two cursors.

## Master Menu




*The master menu offers a convenient way to enable special functions such as the Store and Recall of front panel settings and also allows you to branch-out to other menus.*




*The 7D20T consists of the 7D20 and its own dedicated power module, for use in applications not requiring local visual display of acquired signals.*

## CHARACTERISTICS

### VERTICAL SYSTEM

**Input** — Two channels, simultaneous sampling, BNC connectors.

**Acquire Modes** — CH 1, CH 2, Add, Both (dual channel).

**Sensitivity** — 5 mV to 5 V/div; 1-2-5 sequence.

**Bandwidth** — 70 MHz maximum. (Ac Coupled Low Frequency Response: 10 Hz or less.)

**Step Response** — 5 ns or less.

**Input Impedance** — 1 MΩ paralleled by ≈20 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V, 1 kHz or less (dc + peak ac). Ac Coupled: 400 V, 1 kHz or less (dc + peak ac).

**Signal Isolation** — 100:1 dc to 20 MHz.

**Vertical Resolution** — 8 bits, 256 levels, 0.04 div/level.

**Gain Ratio Accuracy** — <2%. Maximum error throughout the V/div range with acquire gain calibrated at 10 mV/div. Measurement valid with Cursors or GPIB.

**Noise** — Mean value of 50 measurements taken at 0.02 div increments.

| Volts/Div | Full Scale/RMS Noise | Percent of Full Scale |
|---|---|---|
| 5 mV | 52 dB | 0.25 |
| 10 mV to 5 V | 55 dB | 0.18 |

*NOTE: Full scale = 10.24 divisions.*

**Phase Match X-Y** — <2° from dc to 10 MHz.

### HORIZONTAL SYSTEM

**Time Division Range** — External Clock, 20 s/div to 50 ns/div in 1-2-5 sequence.

**Digitizing Technique Versus Time/Division** — Real Time (Rolling Display): External Clock, 20 s/div to 0.1 s/div. Real Time: 50 ms/div to 500 μs/div. Extended Real Time: 200 μs/div to 2 μs/div. Equivalent Time: 1 μs/div to 50 ns/div.

*Note: Single events can be captured as fast as 2 μs/div. For 1 μs/div to 50 ns/div, repetitive events are required to build a complete waveform.*

**Time Measurement Accuracy** — One Cursor: 0.1% of reading +0, −1 sample interval ±300 ps. Two Cursors: 0.1% of reading ±600 ps.

**Horizontal Resolution**

| Time/Division | Points/ Waveform | Resolution Points/Division |
|---|---|---|
| External, 20 s to 500 μs | 1024 | 100 |
| 200 μs to 2 μs | 820*1 | 80*1 |
| 1 μs to 50 ns | 1024 | 100 |

*1 *Waveform interpolation to 1024 points is available for transfer over the GPIB Interface.*

**Trigger Position**

Pretrigger: 0 to 10 div in 1 div increments. Posttrigger (delay): 0 to 1500 div in 1 div increments (disabled during Roll with Envelope or Average).

| | Frequency Range*1 | Sensitivity | |
|---|---|---|---|
| | | Internal | External |
| Normal (Dc Coupling) | dc to 30 MHz | 0.4 div | 60 mV |
| | 30 MHz to 70 MHz | 1.0 div | 150 mV |
| P-P and Auto | 30 Hz to 200 Hz | 2.0 div | 300 mV |
| | 200 Hz to 30 MHz | 0.6 div | 90 mV |
| | 30 MHz to 70 MHz | 1.2 div | 200 mV |

*1 *The ac coupling low frequency limit is 30 Hz. In Time/Div settings of 1 μs to 50 ns, when using P-P or Auto, low-frequency limit is 300 Hz.*

### SIGNAL PROCESSING

**Cursors Readout** — With one cursor (ΔOff), vertical and horizontal coordinate values are referenced to zero volts and the trigger position as zero time. With two cursors (ΔOn), vertical and horizontal coordinate values are the difference between the two cursors.

**Signal Averaging**

AVE N: A self-terminating, stable average processing "N" number of waveforms and then holds the result in memory. The "N" value may be selected using the SET N function (N = 8, 16, 32, 64, 128, 256).

AVE: A continuous, stable averaging process. N waveforms are averaged as in AVEN, then additional waveforms are weighted at 1/N. In Roll mode a running average (smooth) is available to provide high frequency filtering.

**Enveloping**

ENV N: A self-terminating recording of waveform maxima and minima. When N waveforms are processed, the result is held in memory.

ENV: A continuous (infinite) recording of waveform maxima and minima.

**Waveform Modifiers**

VPUP ↑ (Vertical Position Up), VPDN ↓ (Vertical Position Down): Provide vertical positioning control of any stored waveforms.

VCMP ↕ (Vertically Compress), VXPD ↕ (Vertically Expand): Provide vertical display expansion or compression. Two expansions or compressions in 1-2-5 calibrated steps, from the original V/div are available.

HMAG (Horizontal Magnify): Displays the cursor waveform horizontally magnified by a factor of 10.

HMAG ALL (Horizontally Magnify All Waveforms): Displays all waveforms at 10 times horizontal magnification.

VS (Versus): Creates a Y versus X display of any two waveforms.

### GPIB INTERFACE

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T5 | Complete talker — no secondary address |
| L3 | Complete listener — no secondary address |
| SR1 | Complete service request |
| RL1 | Complete remote local |
| DC1 | Complete device clear |
| DT1 | Complete device trigger |
| PP0 | No parallel poll |
| C0 | No controller |
| E2 | Three state |

**Programmable Functions** — All instrument setting and operating modes are programmable except for Variable V/Div and Horizontal Position. However, these uncalibrated controls can be overridden and forced into the "CAL" position on command from the GPIB Interface. The display of Menu and ID is selectable from the front panel only.

**Format** — Device dependent commands in ASCII. Waveform data points selectable as BINARY or ASCII.

**Waveform Output Time** — 250 ms minimum for BINARY and 2.5 s minimum for ASCII. Actual transfer times depend upon the speed of the receiving device.

### INPUTS

**External Trigger (Front Panel)** — Maximum Input Voltage: 250 V (dc + peak ac).

**Signal Input Impedance** — 1 MΩ, paralleled by ≈20 pF.

**Hold Next (Mainframe Rear Panel)** — Initiates Hold Next condition; connected to Single Sweep Reset connector.

### OUTPUTS

**Hold Next Ready** — High level indicates unit is in Hold Next condition; output level remains low when unit is not in Hold Next condition; connected to Single Sweep Ready connector.

**+Gate Out** — Provides high level output signal for duration of waveform/character readout.

### PLUG-IN COMPATIBILITY

The 7D20 is compatible with all 7000 Series mainframes with the exception of the 7104 mainframe. Use with the 7104 will void the 7104 warranty.

### PHYSICAL CHARACTERISTICS

| | 7D20 | | 7D20T | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 206 | 8.1 | 216 | 8.5 |
| Height | 127 | 5.0 | 183 | 7.2 |
| Depth | 371 | 14.6 | 566 | 22.3 |
| **Weight** | **kg** | **lb** | **kg** | **lb** |
| Net | 3.6 | 8.1 | 10.4 | 23.0 |
| Shipping | 8.0 | 17.8 | 12.0 | 26.6 |

## ORDERING INFORMATION

**7D20** Programmable Digitizer (Plug-in) **$7,265**
**Includes:** Instruction manual (070-3857-01); pocket reference guide (070-3205-01).

**7D20T** Programmable Digitizer **$8,865**

**7D20T Option 01** Power Module (Converts Existing 7D20 to 7D20T) **−$7,265**

**TekMAP SOFTWARE**

**7D20/HP Series 200 Software**
Order S42H201 Option 01 (on 5¼" media) **$950**
Order S42H201 Option 02 (on 3½" media) **$950**
**Includes:** Operator manual (070-5649-00).

**7D20/Tek 4041 Software**
Order 062-7732-00 (available on DC-100 tape only) **$150**
**Includes:** Operator manual (070-5227-00). For a fully configured Tek 4041 based measurement system, see the MP 2401 on page 333.

**UTILITY SOFTWARE**

For 7D20/7D20T/4041. Order 062-6959-01 **$150**
For 7D20/7D20T/4052A. Order 062-6961-01 **$150**
See page 297 for description and ordering information.

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**RECOMMENDED PROBE (7D20 and 7D20T)**

**P6053B Identify Probe** — For remote service request via probes "Identify" button. 10X attenuation; 200 MHz bandwidth; scale factor coding; 6 ft. Order 010-6053-13 **$170**

**RECOMMENDED MAINFRAME FOR 7D20**

**R7603 Option 20** — The R7603 mainframe provides a 6-inch diagonal CRT display and three-wide plug-in compartment in a 5.25 inch high rackmount configuration. Option 20 permits rear panel access to the 7D20's GPIB Interface and includes cable 175-7151-00 required inside 7D20. See page 201 for further information. Order R7603 Option 20 Mainframe **$3,720**

**CONVERSION KITS**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 7D20T to the left of a 4041 or another 7D20T. Order 016-0827-00 **$340**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 7D20T to the left of a TM 5003. Order 040-0984-01 **$190**

**Cabinet-to-Rackmount** — Equipped with slide-out assembly to rackmount a 7D20T to the left of a blank plug-in compartment

**OPTIONAL ACCESSORY (R7603)**

A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's GPIB Interface to the R7603 mainframe. Order 040-1093-00 **$380**

# 7854

GPIB IEEE-488 The 7854 is designed to support other products which comply with IEEE Standard 488-1975.

**Waveform Parameters at the Touch of a Key**

**Dc to 400 MHz Real Time Bandwidth at 10 mV/div**

**Calibrated Sweep Rates to 500 ps/div**

**Stores Repetitive Waveforms Up to 14 GHz with Sampling Plug-Ins**

**Single Shot Events and Pretrigger Up to 50 μs/div (with 7B87 Time Base)**

**Signal Averaging**

**Resolution Up to 0.01 Div on Stored Data (10 Bits)**

**Choose 128, 256, 512, 1024 Points/ Waveform**

**Keystroke Programming (Up to 2000 Keystrokes with Option 2D)**

**GPIB Interface (Standard)**

## TYPICAL APPLICATIONS

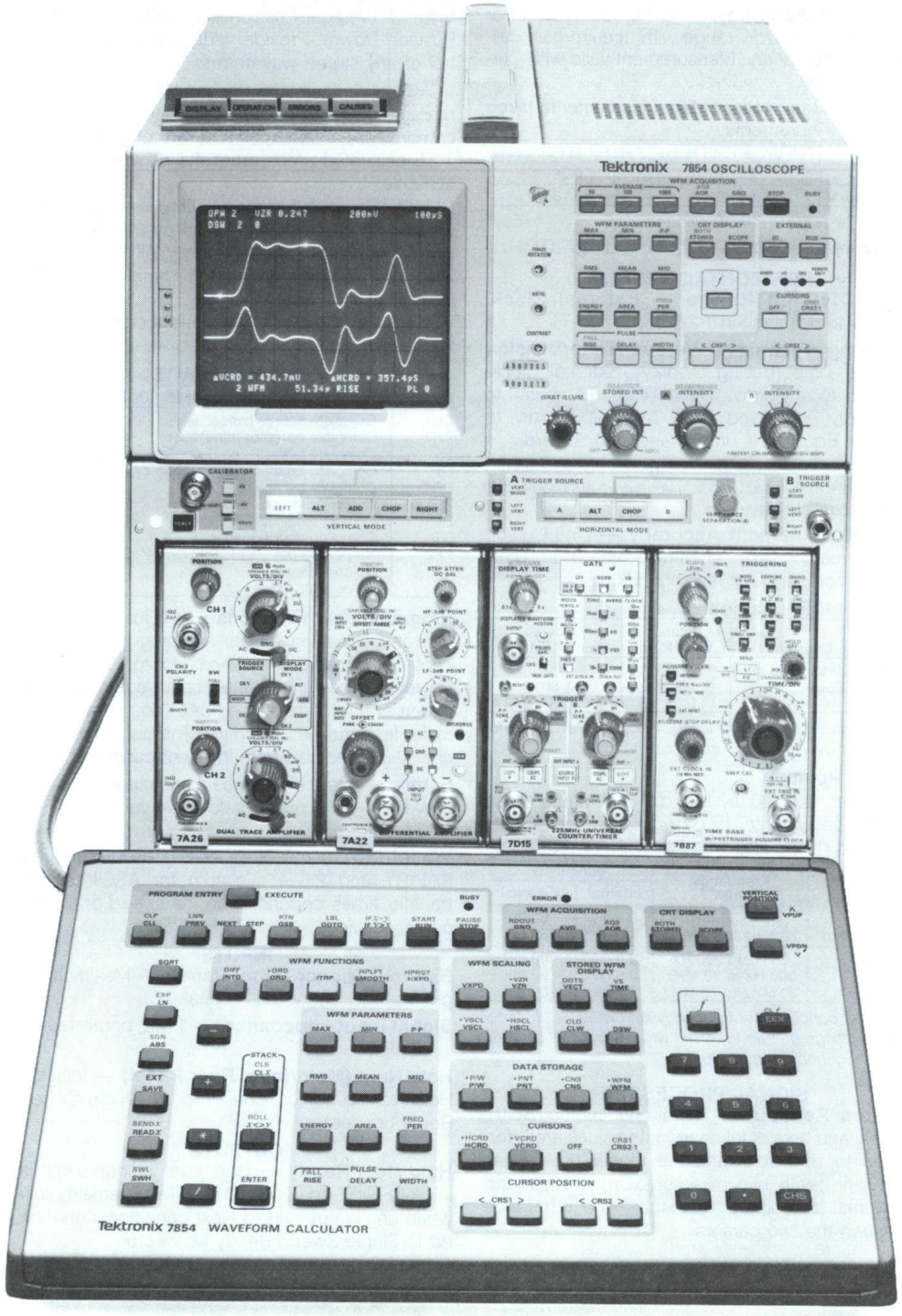
* **Power Supplies Switching**
* **Semiconductors**
* **Fiber Optics**

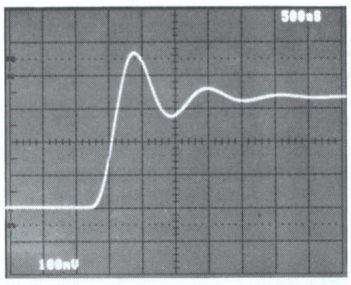
See page 192 for Application Notes

The 7854 Waveform Processing Oscilloscope represents a unique approach to today's test and measurement problems. It combines the features of a high performance real time oscilloscope with digital storage and waveform processing. When integrated with any of a wide variety of 7000 Series plug-ins, it becomes a very powerful measurement system. The 7854 offers programmable measurement routines, GPIB interface for mass data and program storage plus simultaneous display of real time and stored waveforms. The 7854's on-board memory can store up to 40 waveforms and 2000 keystrokes with Option 2D.

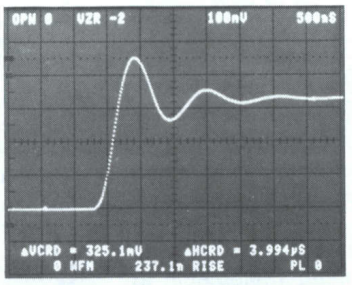
Mainframe and calculator keyboard functions provide cursor control and waveform parameter information at the touch of a button, e.g., maximum, minimum, peak-to-peak, rise. Additional features on the calculator keyboard enable arithmetic manipulation of waveforms such as differential, integral, log, and absolute value.

Signal averaging can recover signals buried in random noise and improve measurement accuracy. One or two cursors are selectable for voltage and time measurements. One cursor provides voltage measurements referenced to ground and time measurements

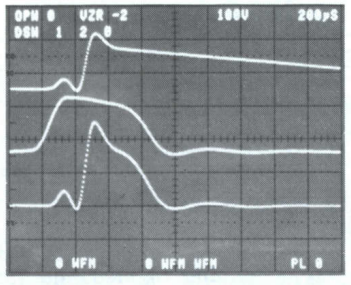




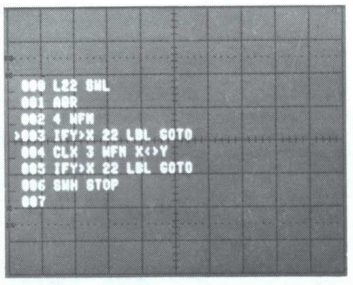
*Conventional Scope: In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high performance scopes.*




*Storage Scope: Risetime is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above risetime.*



*Multiple Storage and Calculation: Volts, current, and power are all shown on the display. Power is a simple two or three keystroke calculation.*




*Waveform Processing: Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.*

referenced to time zero. Two cursors enable Δtime and Δvoltage measurements. Cursors may also be used to bracket an area of interest for measurement consideration.

For low frequency single-shot applications, the 7B87 Time Base plug-in allows storage of events that occur prior to a trigger (pretriggering). The amount of pretrigger data may be varied continuously from 0.2 divisions of pretrigger to 9.9 divisions.

The 7854's keystroke programming (simply storing a series of keystrokes to be executed) assures repeatable measurement results and lowers the skill level needed to operate the system. Measurement loops can be written to save time, log results and make pass/fail decisions. Full subroutine and conditional branching capabilities are provided.

### TekMAP Software Support

The TekMAP (Tektronix Measurement Application Programs) library of software products support the Tektronix 7000 Series GPIB Programmable Digitizers in automated engineering or research environments.

The 7854/IBM PC Communication and Control Software (COMMUTE) supports the 7854 when used in conjunction with an IBM PC or PC compatible, and a Tek GURU or National GPIB board. Its easy to use command-driven menu provides quick access to basic utilities for instrumentation and control. COMMUTE simplifies 7854 operation plus provides diskette storage for waveform, program, and measurement results.

Additional TekMAP products will be available early 1986. Contact your local sales office for information.

## CHARACTERISTICS

### VERTICAL REAL TIME SYSTEM

**Input** — Two plug-in compartments; compatible with 7000 Series plug-ins.

**Modes** — Left, Alt, Add, Chop, Right.

**Mainframe Bandwidth** — 400 MHz with 7A29 or 7A19 Amplifier plug-in.

**Mainframe Step Response** — 0.9 ns or less with 7A29 or 7A19 Amplifier plug-in.

**Chopped Mode** — Chop rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform (7B50 Series time bases not recommended for 7854 except 7B50A).

**Trace Separation Range** — In dual-sweep modes, B trace can be positioned 4 div above or below the A trace.

### CRT AND DISPLAY FEATURES

**CRT Display Modes**

Scope (Conventional display).
Stored (Digital data display).
Both (Stored display plus real time waveforms).
Program Entry (User program text display).

### HORIZONTAL REAL TIME SYSTEM

**Input** — Two plug-in compartments; compatible with 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.*[1] The 7B87 is recommended for pretrigger and single shot digitizing.

**Modes of Operation** — A, Alt, Chop, B.

**Fastest Calibrated Sweep Rate** — 0.5 ns/div.

**Chopped Mode** — Rep rate is ≈200 kHz.

**X-Y Mode** — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction, (dc to 1 MHz with phase correction, B horizontal only, Option 02).

*[1] *See plug-in compatibility for exceptions for digital storage.*

### PROGRAM STORAGE

Keystroke programming allows the mainframe to remember a sequence of keystrokes (with remote waveform calculator or GPIB*[1]).

**Editing** — Line by line editing capability.

*[1] *Mainframe vertical and horizontal modes and all other keys except edit commands are programmable.*

### DIGITAL STORAGE

**Equivalent Time Bandwidth** — 400 MHz. See 7000 Series system bandwidth specifications.

**Accuracy** — Refer to plug-in specifications.

**Acquisition Channels** — One or two simultaneous channels (Plug-in Chop mode not valid).

**Acquisition Window** — ±5 div from center screen both vertical and horizontal.

**Resolution**

Vertical: 0.01 div.

Horizontal: Selectable points/waveform on remote keyboard.

| Horizontal Resolution (divs) | Points/Waveform |
|---|---|
| 0.01 | 1024 |
| 0.02 | 512 |
| 0.04 | 256 |
| 0.08 | 128 |

### PLUG-IN COMPATIBILITY

All 7000 Series plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital storage operation. The 7D01, 7D02 and 7T11 are not compatible in Stored mode.

The 7B87 provides pretrigger for the 7854. Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

**Single Shot Performance** — Using 7B87 with 7854 Internal clock.

**Ext Clock** — 2 μs/point maximum.

| Fastest Sweep (Time/Div) | Points/Waveform |
|---|---|
| 50 μs | 128 |
| 100 μs | 256 |
| 200 μs | 512 |
| 500 μs | 1024 |

## MEMORY FORMAT

| | STANDARD | | | | OPTION 2D | | | |
|---|---|---|---|---|---|---|---|---|
| Points Per Waveform*[1] | 128 | 256 | 512 | 1024 | 128 | 256 | 512 | 1024 |
| Maximum Number of Waveforms | 16 | 8 | 4 | 2 | 40 | 20 | 10 | 5 |
| Maximum Number of Constant Registers | 50 | | | | 100 | | | |
| Maximum Number of Prog Commands plus lines | 920 | | | | 2000 | | | |

*[1] *Unless otherwise selected, default value is 512 at power-up.*

## OUTPUTS/INPUTS

**+Sawtooth —** Positive-going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is ≈950 Ω.

**+Gate —** Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is ≈950 Ω. Source is selectable from A gate, B gate, or Delayed gate.

**Vertical Signal Out —** Selected by A Trigger Source switch. Output voltage is 0.5 V/div into 1 MΩ, 25 mV/div into 50 Ω. Output R is ≈950 Ω. Bandwidth depends upon vertical plug-in.

**Remote Single Sweep Reset —** Rear panel BNC, ground closure activated.

**TTL Output —** Rear panel BNC, TTL output under remote keyboard control (SWH and SWL).

**External Z-Axis Input —** 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

**Camera Power Output —** Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Memory Back-Up Power Input —** 6.0 V to 6.5 V at 0.7 amp to preserve stored data if mainframe's power is interrupted.

## GPIB INTERFACE

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T5 | Talker function |
| L3 | Listener function |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local capability |
| DC1 | Complete device clear capability |
| DT1 | Complete device trigger capability |
| PPØ | No parallel poll z |
| CØ | No controller function z |

**I/O Records —** Waveforms constants, program text, and display text.

**End of Message Terminator (Selectable in Talk/Listen Mode for EOI or LF/EOI) —** Compatible with Tektronix and other popular controllers.

**Device Address —** Selectable via rear panel switch.

**Remote Operation —** All keystroke functions and vertical and horizontal modes can be remotely operated via the GPIB.

## CALIBRATOR

**Voltage Output —** Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

**Current Output —** 40 mA available through Calibrator output with optional BNC to current loop adaptor.

## POWER REQUIREMENTS

**Line Voltage Ranges —** 90 V to 132 V. 180 V to 250 V.

**Line Frequency —** 48 Hz to 440 Hz.

**Maximum Power Consumption —** 230 W.

## PHYSICAL CHARACTERISTICS

| Dimensions, Mainframe | mm | in |
|---|---|---|
| Width | 305 | 12.0 |
| Height | 348 | 13.7 |
| Depth | 627 | 24.7 |
| **Waveform Calculator** | **mm** | **in** |
| Width | 277 | 10.9 |
| Height | 69 | 2.7 |
| Depth | 165 | 6.5 |
| Cord Length (within 76 mm) | 1420 | 56.0 |
| **Weights** | **kg** | **lb** |
| Net | 20.4 | 45.0 |
| Shipping | 28.2 | 62.0 |

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7854** Oscilloscope (Including Waveform Calculator) **$15,830**

**Includes:** Power cord (161-0066-00); BNC-to-BNC cable (012-0208-00); instruction manual (070-2873-00).

### OPTIONS

**Option 02 —** X-Y Phase Correction. **+$260**

**Option 03 —** EMC Modification. **+$395**

**Option 2D —** 4 k Expanded Memory. **+$265**

**Field Option 2D Kit —** Order 040-0941-00. **$300**

**Option 78 —** BE (P11) Phosphor. **+$100**

**7B87** Time Base required only for pretrigger and single shot digitizing. See page 220 for complete description. **$1,800**

### TekMAP SOFTWARE

**7854 IBM PC Software**
Order S42P101 **$450**

**Includes:** Software operator manual.

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1 —** Universal Euro 220 V/16 A,50 Hz.
**Option A2 —** UK 240 V/13 A, 50 Hz.
**Option A3 —** Australian 240 V/10 A, 50 Hz.
**Option A4 —** North American 240 V/15 A, 60 Hz.
**Option A5 —** Switzerland 220 V/10 A, 50 Hz.

## OPTIONAL ACCESSORIES

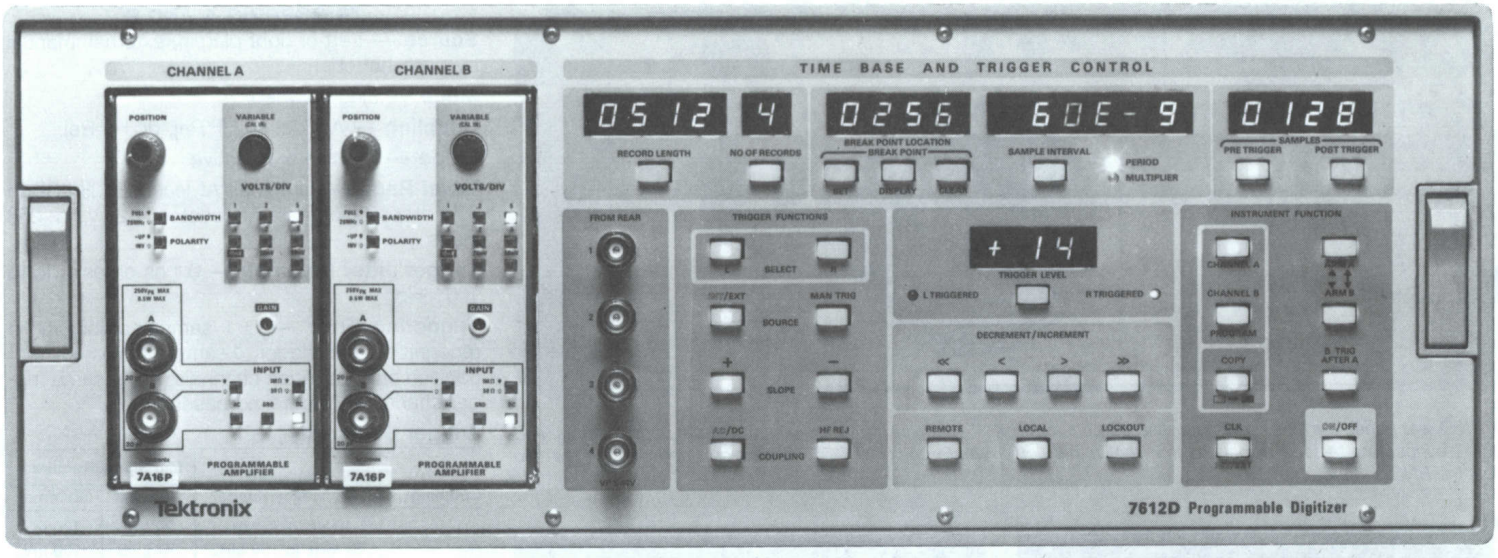
**Recommended Plug-ins —** See page 190.
**Recommended Probes —** See page 426.
**Recommended Cameras —** See page 406.
**Recommended Cart —** The K213 Lab Instrument Cart is recommended for all 7000 Series mainframes. A keyboard tray for the 7854 and a storage area for plug-ins are available as Options 10 and 12 respectively, Option 22 for both. See page 424.

### SYSTEMS

**The 7854 is also available as an MP 2501 Acquisition/Processing Package. This system is a combination of the Tektronix 7854 Oscilloscope and 4041 Controller. Together, these two instruments automate the entire waveform test and measurement process, from acquisition and calculation to storage and display formatting.**

**Tektronix offers service training classes on the 7854 Waveform Processing Oscilloscope.**

**For further training information, contact your local sales/service office or request a copy of the Tektronix Service Training Catalog.**




# 7612D

GPIB IEEE-488

The 7612D complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats*.

**200 MHz Maximum Sampling Rate**

**Two Channels, Two Time Bases**

**8 Bit Resolution**

**2048 Words of Memory per Channel**

**5 ns to 1 s Selectable Sampling Intervals with Interval Switching Allowed During Waveform Acquisition**

**Pretrigger and Posttrigger Operation**

**Fully Programmable Over GPIB for System Oriented Operation**

## TYPICAL APPLICATIONS

* **Automated Testing**
* **LIDAR**
* **EMP**
* **Nondestructive Testing**

The 7612D Programmable Digitizer is a dual-channel, dual time base waveform digitizer for use under computer control. It has a maximum sampling rate of 200 MHz. Each channel has its own analog-to-digital converter, designed by Tektronix for accurate, high-speed waveform digitizing. Each channel also has its own time base operating from a single 200 MHz crystal-controlled clock. The result...two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time-base settings.

And there's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digitizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. You have the choice, too, of looking at waveforms before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Or you can choose to operate the channels dependently by triggering one after the other.

All 7612D functions can be selected manually or operated under program control over the GPIB. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform acquisition function.

Extracting information from medium-speed signals is a typical application of 7612D systems.

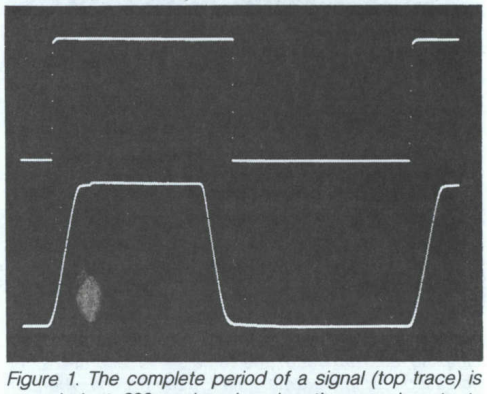


*Figure 1. The complete period of a signal (top trace) is recorded at 200 ns; by changing the sample rate to 10 ns during risetimes and falltimes and 800 ns during the plateau (bottom trace), you can measure risetime, falltime, pulse width and interval accurately on a single-shot signal.*

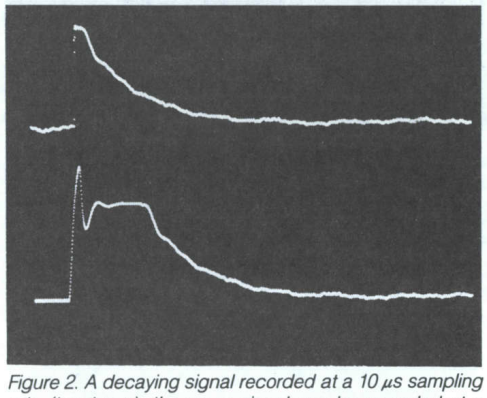
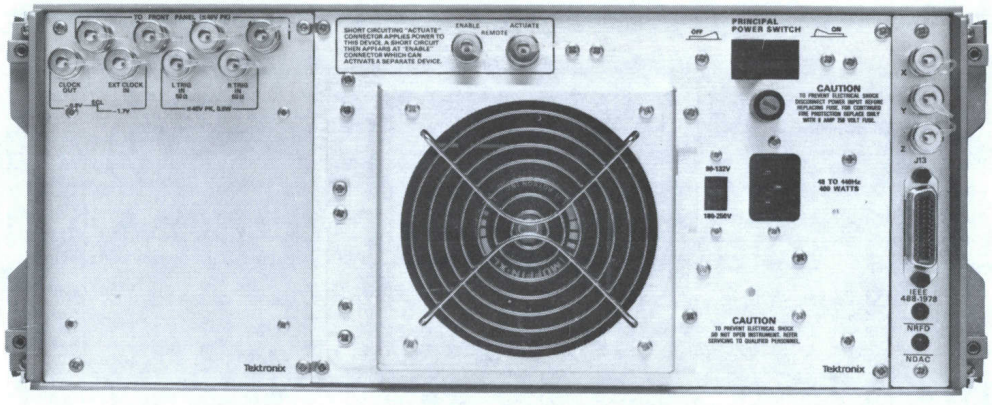


*Figure 2. A decaying signal recorded at a 10 µs sampling rate (top trace); the same signal can be recorded at a 100 ns sampling rate during the initial portion and switched back to a 10 µs sampling rate (bottom trace), to capture all information on a single-shot signal.*




*7612D rear panel: the GPIB connector and outputs for an X-Y-Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left): remote power ON/OFF is also provided through the two central BNC connectors.*

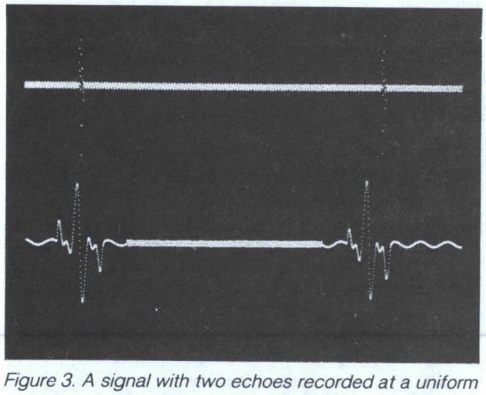


*Figure 3. A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.*

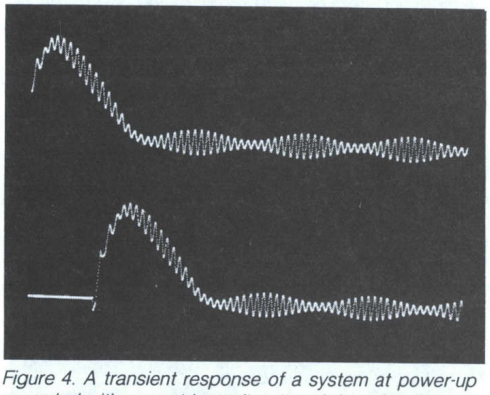


*Figure 4. A transient response of a system at power-up recorded with no pretrigger (top trace); by using the pretrigger the complete response can be digitized (bottom trace).*

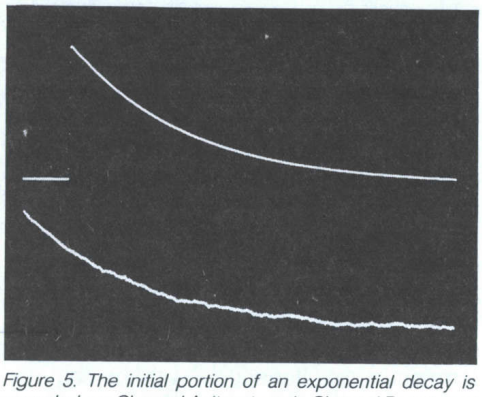


*Figure 5. The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after Channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).*

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments compatible with all 7000 Series amplifier plug-ins. Fully programmable when 7A16P plug-ins are used.

**Bandwidth** — 80 MHz with 7A16P plug-in.

**Modes of Operation** — Left channel with Time Base A and right channel with Time Base B.

### TIME BASES A AND B

**Type** — Two built-in digital time bases with a common crystal-controlled clock.

**Clock** — Internal: 200 MHz ±0.0035%. Stability: Within 10 ppm/year. External: From signal source ≤200 MHz.

**Sample Interval** — With Internal Clock: Selectable from 5 ns to 1 s in a 1, 2, 3...9 sequence (excluding 6, 7, 8 and 9 ns). With External Clock: Selectable from 1 to 200 x $10^6$ times the external clock period in a 1, 2, 4, 6...20 sequence.

**Interval Switching** — Sample interval can be changed up to 13 times/waveform record with preservation of time relationships.

**Time Measurement Accuracy** — 0.0035% (stability 10 ppm/year).

**Modes of Operation** — Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

### TRIGGERING A AND B

**Source** — Left or right plug-in, external, manual by push button.

**Mode** — Single sweep.

**Coupling** — Ac, dc, ac HF Rej, dc HF Rej.

**Slope** — Positive or negative.

**Level Range** — Internal: At least ±128 LSB in 256 steps. External: At least ±1.28 V in 256 steps.

**Trigger Jitter (Internal)** — 0.1 ns or less, dc to 100 MHz.

**Triggering Error** — ±1 sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).

**Trigger Sensitivity**

| Coupling | Triggering Frequency Range | Min Signal Required | |
|---|---|---|---|
| | | Internal | External |
| Ac | 40 Hz to 50 MHz | 20 LSB | 100 mV |
| | 50 MHz to 100 MHz | 44 LSB | 100 mV |
| Ac HF Rej | 40 Hz to 50 kHz | 20 LSB | 100 mV |
| Dc | Dc to 50 MHz | 20 LSB | 100 mV |
| | 50 MHz to 100 MHz | 44 LSB | 100 mV |
| Dc HF Rej | Dc to 50 kHz | 20 LSB | 100 mV |

### ARMING A AND B

Push button or computer control.

### DIGITIZING AND STORAGE

**Method** — Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.

**Resolution** — Eight bits.

**Dynamic Accuracy*1**

| Signal Frequency | S/N Ratio | Effective Bits |
|---|---|---|
| 300 kHz | 42.0 dB | 7.8 |
| 20 MHz | 32.0 dB | 6.0 |
| 80 MHz | 20.0 dB | 4.0 |

**1 Signal to noise ratio performance at 25° C for a half scale sinewave input signal (an ideal eight bit digitizer would give a S/N ratio of 43.8 dB). For further information refer to HANDSHAKE VOL 5 NO 1, 33-A-4463.*

**Internal Memory** — Type: ECL. Size: 2048 8-bit/channel, total of 4096 8-bit words.

**Record Length, A or B** — 256, 512, 1024, or 2048 samples. Number of Stored Records: Up to eight 256-word, four 512-word, two 1024-word, or one 2048-word records/channel (each requires a trigger). Trigger is automatically rearmed after each record acquisition.

**Pretrigger Delay Range** — Selectable in multiples of eight samples. Without Sample Interval Switching: From 0 up to 16 samples less than the record length. With Sample Interval Switching: From 0 up to 16 samples less than the position of the first sample interval change.

**Posttrigger Delay Range** — Selectable in multiples of eight samples from eight to the record length (requires selection of only one record).

### OUTPUTS/INPUTS

**X, Y, Z Analog Output** — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 kΩ or greater.

**Clock Out** — Provides internal clock signal at ECL level.

**External Clock In** — ECL levels. ≤1 ns risetime and falltime. 2.5 ns minimum pulse width and ≤200 MHz.

**L and R Trig In** — Provide external trigger input to the left and right trigger channels (50 Ω terminated).

**1, 2, 3, 4** — Four feed-through connections to the front panel.

**Digital Interface** — Conforms to IEEE Standard 488-1975.

### GPIB INTERFACE

**Standard** — Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| TE6 | Extended talker function |
| LE4 | Extended listener function |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local function |
| PP0 | No parallel poll |
| DC1 | Complete device clear capability |
| C0 | No controller function |
| DT0 | No device trigger |

**Response to Interface Control Messages** — The 7612D responds to the following interface control messages:

| | |
|---|---|
| GTL | Go to local |
| LLO | Local lockout |
| SDC-DCL | Selected device clear and device clear |
| SPE-SPD | Serial poll enable and disable |
| IFC | Interface clear |

**GPIB Addresses** — Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.

**Programmable Functions** — All instrument settings and operating modes are programmable.

**Format** — Commands in ASCII, waveform data in binary (range 0 to $377_8$).

**Transfer Rate** — 710 kbytes/s maximum.

**Waveform Transfer Time** — To an Infinitely Fast Controller: 8.35 ms for one 2048 points record. Actual transfer time depends on controller and software speed.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 132 V ac, 180 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption (Including Plug-ins)** — Maximum 400 W, 5 A at 115 V 60 Hz.

**Remote Control** — Power On/Off capability is provided.

### ENVIRONMENTAL

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: −62°C to +85°C.

**Altitude** — Operating: −76 m to +4600 m (−250 ft to +15,000 ft). Nonoperating: −76 m to +15 000 m (−250 ft to +50,000 ft).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 178 | 7.0 |
| Depth | 703 | 27.7 |
| **Weights** | **kg** | **lb** |
| Net | 25.0 | 55.0 |

## 7A16P

**Fully Programmable Plug-In for 7912AD or 7612D Digitizers Only**

**10 mV/div to 5 V/div Calibrated Deflection Factors**

**200 MHz Bandwidth (7900 Family)**

**50 Ω or 1 MΩ Input Selectable**

The 7A16P is designed for use in Tektronix 7000 Series programmable digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the GPIB. Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the GPIB by an external controller for input to instrument setup and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

### CHARACTERISTICS

**Bandwidth** — Plug-in Only: 225 MHz. With the 7912AD: 200 MHz. Bandwidth may be limited to 20 MHz ±3 MHz by bandwidth limit switch.

**Ac Coupled Lower Bandwidth** — 10 Hz or less.

**Step Response** — 50 Ω input plug-in only, 1.8 ns risetime.

**Deflection Factor** — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is ±2% of indicated deflection factor with Gain adjusted at 10 mV/div. Uncalibrated Variable is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.

**Input R and C** — Selectable: 1 MΩ within 2% and paralleled by ≈20 pF or 50 Ω ±1 Ω with vswr ≤1.5:1 at 200 MHz or less.

**Inputs** — Selectable A or B signal input connectors.

**Maximum Input Voltage** — 1 MΩ, Dc Coupled: 250 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 1 MΩ, Ac Coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50 Ω: 0.5 W maximum.

**Programmable Functions** — All functions except Variable, Gain, and Identify are programmable.

### ORDERING INFORMATION

**7612D** Programmable Digitizer **$28,075**

**Includes:** GPIB cable (012-0630-03); set of rack slides (351-0375-01); power cord (161-0066-00); operator manual (070-2386-00).

#### INTERNATIONAL POWER PLUG OPTIONS

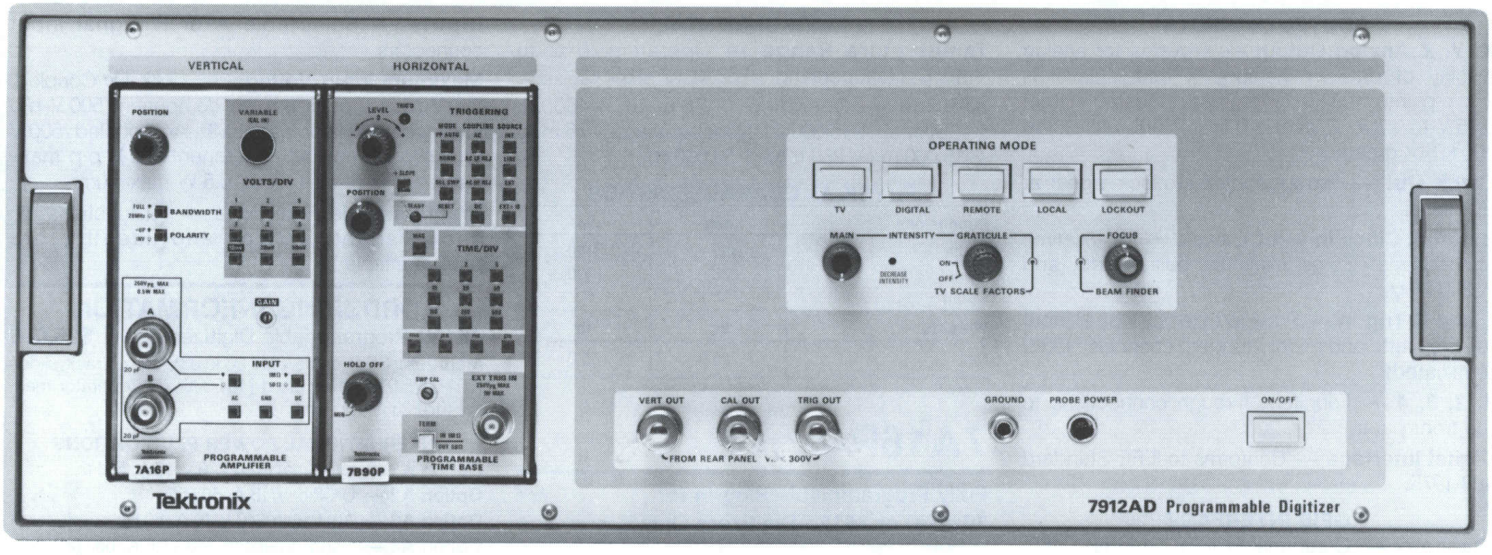
**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**7A16P** Programmable Amplifier **$2,395**

#### SYSTEMS

**The 7612D is also available in MP 1201/MP 2201 Measurement Packages and MS 3201 Acquisition/Processing Measurement System. The measurement system is designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the second to submicrosecond range. For more information on these systems or packages, contact your local Tektronix sales engineer.**

**Tektronix offers service training classes on the 7612D Programmable Waveform Digitizer. For further training information, contact your local sales/service office or request a copy of the Customer Service Training Catalog.**




*7912AD shown with the 7A16P and 7B90P programmable plug-ins.*

# 7912AD

GPIB IEEE-488

The 7912AD complies with IEEE Standard 488-1975, and with Tektronix *Standard Codes and Formats.*

**Digitize and Store Single-Shot or Repetitive Signals from Millisecond to Subnanosecond Duration**

**500 MHz Bandwidth at 10 mV/div**

**500 ps/div Fastest Calibrated Sweep Rate**

**Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution**

**Built-In Signal Averaging Capability**

**Fully Programmable Over GPIB for System Oriented Operation**

## TYPICAL APPLICATIONS

* **Destructive Testing**
* **Laser Research**
* **LIDAR**
* **Automated Testing**

Capturing high-speed waveforms is the 7912AD's forte. Each waveform can be sampled up to 512 times within a selectable time window, ranging from ten milliseconds to five nanoseconds (50 kHz to 100 GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter which writes the signal onto a silicon-diode target array. In TV mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital mode the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the GPIB to an external controller for processing.

The 7912AD mainframe is programmable over the same GPIB. When the programable plug-ins (one 7A16P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912AD becomes a fully programmable digitizer with a bandwidth of 200 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Channels** — Single plug-in compartment accepts any 7000 Series amplifier plug-in. Fully programmable when 7A16P is used.

**Bandwidth (Determined by Amplifier Plug-In)** — 7A16P: 200 MHz. 7A29: 500 MHz.

**Delay Line** — Permits viewing of leading edge of acquired waveform.

### HORIZONTAL SYSTEM

**Channels** — Single plug-in compartment accepts any 7000 Series time base. Fully programmable with 7B90P.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B90P or 7B92A Time Bases.

**Slowest Recommended Sweep Rate** — 1 ms/div in Digital mode.

### DIGITIZING AND STORAGE

**Method** — Scan conversion.

**Resolution** — Nine bits. In the Digital mode, the target is scanned in a 512 x 512 point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.

**Writing Rate (+10°C to +40°C)** — TV Mode: Writes an 8 div sinewave of at least 500 MHz in a single sweep. Digital Mode: Stores a single 8 div pulse with a risetime of 1 ns or less.

**Target Defects** — No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.

**Memory** — Type: Semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples/waveform maximum.

### ELECTRONIC GRATICULE

8 x 10 div dot matrix written onto the scan converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

### OUTPUTS/INPUTS

**X, Y, Z Analog Output** — Provides for analog display of data in memory. X and Y level is 1 V p-p into 100 kΩ or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 V to 1 V (full white) into 100 kΩ or greater.

**Composite Video Output** — Only available in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.

**Sync Output** — At least 4 V into 75 Ω. Conforms to EIA RS-170.

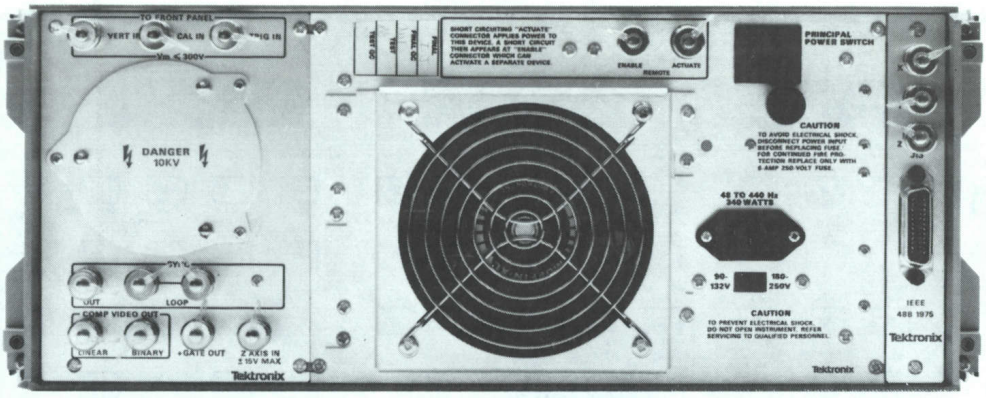
**Sync Loop** — Allows TV mode to be synchronized with external EIA RS-170 sync waveform.

**+Gate Output** — Provides a positive pulse with a duration equal to and coincident with the time base sweep.

**Z-Axis Input** — ±1 V input modulates the writing gun intensity over its full range.

**Vert In, Cal In, Trig In** — Three internal 50 Ω coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rackmounts.

**Probe Power** — Provides power for Tektronix active probes.




## GPIB INTERFACE

**Standard** — Conforms to IEEE Standard 488-1975.

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| TE6 | Extended talker function |
| LE4 | Extended listener function |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local function |
| PPØ | No parallel poll |
| DC1 | Complete device clear capability |
| CØ | No controller function |
| DT1 | Device trigger complete |

## ENVIRONMENTAL

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: Up to 4600 m (15,000 ft). Nonoperating: Up to 15 000 m (50,000 ft).

**EMC (plug-ins inserted)** — Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

## POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 132 V ac and 180 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power Consumption (Including Plug-ins)** — 360 W maximum.

**Remote Control** — Remote power On/Off capabilities provided.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 483 | 19.0 |
| Height | 178 | 7.0 |
| Length | 679 | 26.8 |
| **Weight** | **kg** | **lb** |
| Net | 24.7 | 54.6 |

# 7A16P

**Fully Programmable Plug-in for 7912AD or 7612D Digitizers Only**

**10 mV/div to 5 V/div Calibrated Deflection Factors**

**200 MHz Bandwidth (7900 Family)**

**50 Ω or 1 MΩ Input Selectable**

For complete specifications on 7A16P see page 323.

# 7B90P

**500 ps/div to 500 ms/div Calibrated Time Base**

**Fully Programmable Plug-in 7912AD Digitizer Only**

**400 MHz Trigger Bandwidth**

**Single-Sweep Operation**

The programmable 7B90P is designed for use with a Tektronix 7912AD Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the GPIB. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

## CHARACTERISTICS

**Sweep Rates** — 500 ms/div to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.

**Sweep Accuracy** — Measured over center 8 div, +15°C to +35°C, with any 7000 Series programmable mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

| Time/Div | Unmagnified | Magnified |
|---|---|---|
| 500 ms/div to 100 ns/div | 2% | 3% |
| 50 ns/div to 10 ns/div | 3% | 4% |
| 500 ps/div | — | 5% |

**Trigger Holdoff** — Programmable in 62 steps between minimum and maximum.

| Time/Div | Min (ccw) | Max (cw) |
|---|---|---|
| 500 ps/div to 2 μs/div | ≤3.5 μs | ≥90 μs |
| 5 μs/div to 20 μs/div | ≤35 μs | ≥900 μs |
| 50 μs/div to 200 μs/div | ≤350 μs | ≥9 ms |
| 500 μs/div to 2 ms/div | ≤3.5 ms | ≥90 ms |
| 5 ms/div to 500 ms/div | ≤35 ms | ≥900 ms |

**Triggering Sensitivity**

P-P AUTO MODE

| Triggering Frequency Range | Min Signal Required | |
|---|---|---|
| | Int | Ext |
| At least 50 Hz | 2.0 div | 500 mV |
| 200 Hz to 50 MHz | 0.5 div | 125 mV |
| 50 MHz to 400 MHz | 1.5 div | 375 mV |

NORM MODE

| Coupling | Triggering Frequency Range | Min Signal Required Int | Min Signal Required Ext*1 |
|---|---|---|---|
| Ac | 30 Hz to 50 MHz | 0.3 div | 100 mV |
| | 50 MHz to 400 MHz | 1.5 div | 250 mV |
| Ac LF Rej*2 | 30 kHz to 50 MHz | 0.3 div | 100 mV |
| | 50 MHz to 400 MHz | 1.5 div | 250 mV |
| Ac HF Rej*3 | 30 Hz to 50 kHz | 0.3 div | 100 mV |
| Dc | Dc to 50 MHz | 0.3 div | 100 mV |
| | 50 MHz to 400 MHz | 1.5 div | 250 mV |

*1 *Ext ÷ 10 operation attenuates ext trigger signal 10 times.*

*2 *Will not trigger on sinewaves or <8 div Internal, or 3 V External, at or below 60 Hz.*

*3 *Will not trigger on 50 MHz sinewaves 1.5 div or less Internal, or 0.15 V or less External.*

**Single-Sweep Mode** — Same as Norm mode.

**Trigger Level** — Programmable in 0.05 div steps.

**Horizontal Position** — Programmable in 0.0125 div step unmagnified, 0.125 div step magnified.

**Internal Trigger Jitter** — 0.1 ns or less at 400 MHz.

**External Trigger Input** — Selectable: 1 MΩ ±5%, 20 pF ±10% or 50 Ω ±5% with 1.22:1 maximum vswr at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or 1 W for 50 Ω. The level range (excluding p-p Auto) for a 1 kHz sinewave input is at least ±3 V in Ext and at least ±30 V in Ext ÷ 10.

## ORDERING INFORMATION

**(PLUG-INS NOT INCLUDED)**

**7912AD** Programmable Digitizer **$27,025**

**Includes:** Power cord (161-0066-00); set of rack slides (351-0375-01); GPIB cables (012-0630-03); operator manual.

**Option 13** — Change TV Scan to 625 lines at 50 Hz. **NC**

**Option 30** — Delete GPIB Cable. **−$90**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**7A16P** Programmable Amplifier **$2,395**

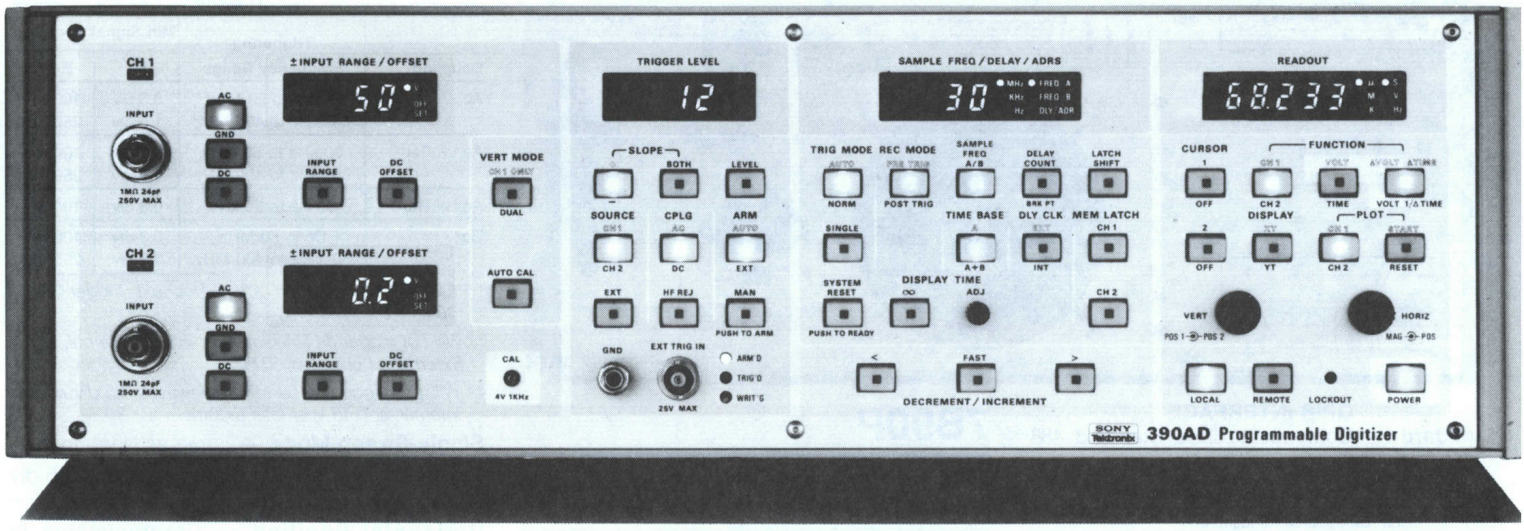
**7B90P** Programmable Time Base **$2,885**

It is recommended that 7912ADs not be purchased or operated without an accompanying 634 Raster Scan Display Monitor. Contact your local sales engineer for details.

**SYSTEMS**

**The 7912AD is also available in the MP 1101/MP 2101 Measurement Packages and the MS 3101 Acquisition/Processing Measurement System. The measurement systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the millisecond to nanosecond range. For more information on these systems and packages contact your local Tektronix sales engineer.**

**Tektronix offers service training classes on the 7912AD Programmable Transient Waveform Digitizer. For further training information, contact your local sales/service office or request a copy of the Customer Service Training Catalog.**




# 390AD

GPIB IEEE-488 The 390AD complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**True Dual Channel 30 MHz Sampling Rate (60 MHz in Single Channel Mode)**

**10-Bit Resolution**

**2048 Word Memory Per Channel (4096 Single Channel Mode)**

**Cursor-Based Measurements**

**Sample-Rate Switching**

**Direct Plotter Output Capabilty**

## TYPICAL APPLICATIONS

- **Extracting Information from Signals Containing Components from dc to 15 MHz**
- **Ultrasonics/Stress/Strain**
- **Mechanical/Vibration**
- **Audio**
- **ATE**
- **Laser Spectroscopy**
- **Biomedical Research**
- **LIDAR**
- **Geo-Seismic**

Used for low-to-medium-speed signals, the 390AD Programmable Waveform Digitizer provides crystal-controlled, 30 MHz sampling on two channels. Or, a single channel of data may be digitized at up to 60 megasamples per second.

Features include 10 bit vertical resolution, dual-channel synchronized digitizing, pretriggering and posttriggering, sample-rate switching during acquisition, internal cursors for two-point time or voltage measurements and 2048 words of memory per channel. Excellent dynamic accuracy is achieved using a two-stage flash-conversion process.

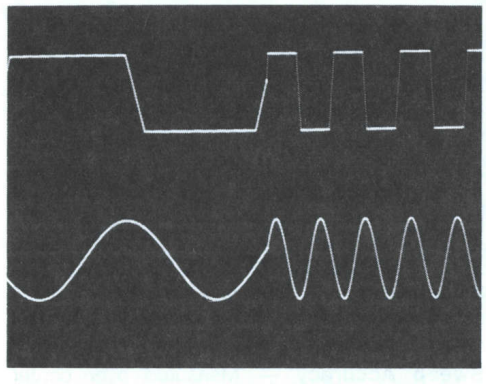


*Figure 1. Photo showing sample of Rate Switching. In this example switching occurs at the 1024th sample, to extend the display window. The sample rate can be either increased or decreased at the trigger point. A minor time discontinuity may occur at the trigger point under some conditions.*

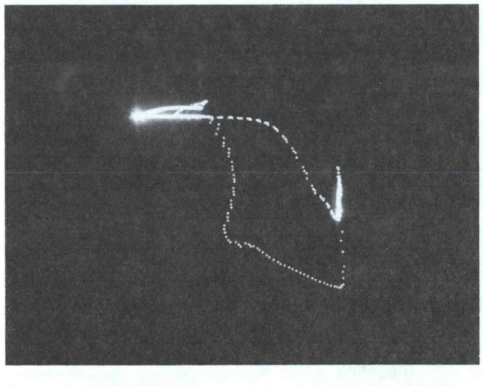


*Figure 2. The 390AD display is set to X vs Y mode.*

The X versus Y display mode coupled with the shift mode function provides a powerful tool for visual comparison of related phenomena.

To ensure reliable operation and high accuracy, the 390AD includes Auto Cal (self-calibration) and self-test features during operation.

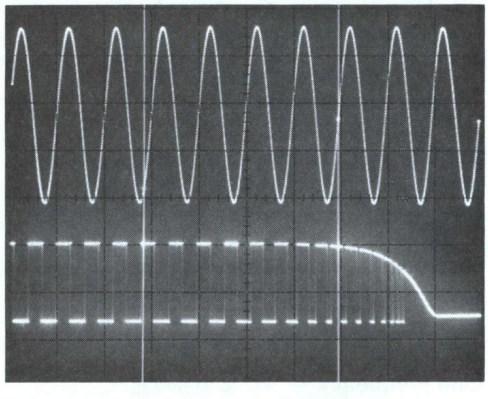


*Figure 3. Two cursors may be positioned by the user or controller, at points of interest on either waveform. The voltage difference, time difference, or 1/time difference, as well as the absolute values may be directly read from the LED display, or sent to a controller. Positioning may be precisely accomplished with the aid of the "zoom" feature.*

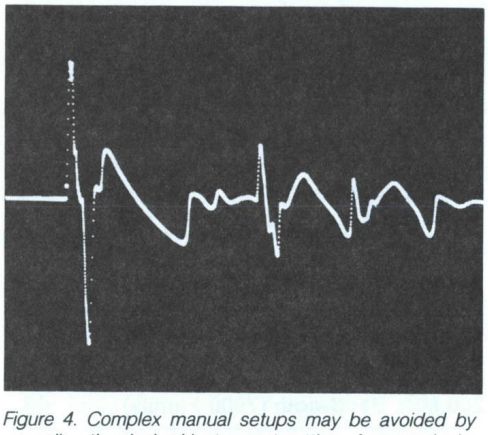


*Figure 4. Complex manual setups may be avoided by recording the desired instrument settings for a particular measurement on a system peripheral device, then sending the English-like command string to the 390AD.*

*Figure 5. The 390AD can be easily integrated into wide range of GPIB systems. Shown above is a 4695 Color Hard Copy Unit and a 4105A Color Terminal which is connected to a Tektronix 4041 System Controller.*

## CHARACTERISTICS

### VERTICAL

**Input Channels** — Two, single ended.

**Sensitivity** — ±100 mV to ±50 V full scale (200 mV p-p to 100 V p-p) 9 steps, 1-2-5 sequence.

**Input R and C** — 1 MΩ ±2%; paralleled by ≈24 pF.

**Maximum Input Voltage** — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 500 V (dc + peak ac).

**Bandwidth** — Dc to 15 MHz (−3 dB). Lower −3 dB point, Ac Coupled: 10 Hz.

**Input Dc Offset Voltage** — 0 to ±99% full scale, 1% step. Accuracy: <0.5%.

**Automatic Calibration** — Gain Accuracy: ±0.4%. Dc Drift Accuracy: <±0.1%.

### TIME-BASE A AND B

**Sample Rate** — Internal: CH 1 Only: 5 Hz to 60 MHz, 23 steps, 1-2-5 sequence except 30 MHz and 60 MHz. Dual: 5 Hz to ≈30 MHz, 22 steps. External: Dc to 60 MHz.

**Clock** — 60 MHz ±10 ppm, crystal-controlled.

### TRIGGERING

**Sources** — Internal CH 1 and CH 2 or external.

**Coupling** — Ac, dc, HF Rej.

**Slope** — Positive, negative, both.

**Level Range** — Internal: 0 to ±99% full scale, 1% step. External: ±4.95 V, 0.05 V step.

**Trigger Sensitivity**

| Coupling | Trigger Frequency Range | Minimum Signal Required | |
|---|---|---|---|
| | | Internal | External |
| Ac | 25 Hz to 15 MHz | 30 LSB | 300 mV p-p |
| HF Rej | 25 Hz to 50 kHz | 30 LSB | 300 mV p-p |
| Dc | Dc to 15 MHz | 30 LSB | 300 mV p-p |

**Arming** — Auto, Manual, External.

### DIGITIZING

**Vertical Resolution** — 10 bits (1/1024).

**Sample Rates** — Dual Channel Mode: 30 MHz. CH 1 Only Mode: 60 MHz.

**Aperture Jitter (Including Internal Clock)** — 150 ps, nominal.

**Dynamic Accuracy*1**

| Signal Frequency | Effective Bits |
|---|---|
| ≤1 MHz | ≥8.75 |
| ≤10 MHz | ≥8.25 |
| ≤14 MHz | ≥7.75 |

**1 Sampling frequency at 30 MHz. For further information refer to HANDSHAKE Vol 5 No 1, 33-A-4463.*

**Record Length** — Dual Channel Mode: 2048 words/channel. CH 1 Only Mode: 4096 words.

**Modes** — Auto, Norm, Single.

**Pretrigger Range** — CH 1 Only Mode: 0 to 4092. Dual Channel Mode: 0 to 2046.

**Posttrigger Range**

| Time Base | Vertical Mode | Range |
|---|---|---|
| A | Dual<br>CH 1 only | 0 to 9998<br>0 to 9998 |
| A+B | Dual<br>CH 1 only | 0 to 2046<br>0 to 4092 |

**A Time Base** — Recording is taken at one rate (sample frequency A) continuously.

**A+B Time Base** — Pretrigger Mode: Sample frequency A is switched to B at trigger. Recording stops at delayed trigger. The transition point (switch point) is well defined. Posttrigger: Sample frequency A is switched to B at delayed trig and recording stops after total of 2048 (or 4096) samples.

Stored digital data are addressable by key entry while monitoring cursors on the waveform.

**Readout Display** — Five digit LED (Reads voltage difference on the same waveform or between CH 1 and CH 2, absolute voltage, time interval, and 1/T.

### OUTPUTS

**CRT Display** — X: 1 V p-p Ramp (changeable to 5 V p-p by internal strap). 8 ms: Dual. 16 ms: CH 1 only. Mag gain X1 to X10 variable. Y: 1 V p-p (changeable to 5 V p-p by internal strap). Z: 0 to 1 V (changeable to 0 to 5 V by internal strap), selectable polarity. X-Y Plot: Output Voltage is 0 to 5 V. Plot Speed is 20, 50, 100 ms/word: Auto Slow, or Auto Fast modes. (Modes are selected by internal strap.)

**Voltage Calibrator** — Rectangular 1 kHz (±$10^{-5}$), 4 V (±1%).

**Rear Panel Connectors** — CRT-X, CRT-Y, CRT-Z, INT CLK-OUT, EXT CLK-IN, EXT ARM-IN, EXT DLY CLK-IN, PLOT-X, PLOT-Y, PLOT-PEN, WRITE END, GPIB.

### GPIB INTERFACE

**Standard** — Conforms to IEEE Standard 488-1978.

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T6 | Basic talker |
| L4 | Basic listener |
| SR1 | Complete service request capability |
| RL1 | Complete remote/local capability |
| PP0 | No parallel poll |
| DC1 | Complete device clear capability |
| C0 | No controller function |
| DT1 | Complete device trigger capability |

**Interface Control Message** — GTL, LLO, SDC-DCL, GET, SPE-SPD, IFC.

**Programmable Functions** — All instrument setting and operating modes are programmable, except power switch, vertical/horizontal position, horizontal mag, and external clock switch.

**Format** — Commands in ASCII, Waveform data in 2 byte/point high byte first.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V ac to 132 V ac (115 V); 180 V to 250 V ac (230 V).

**Line Frequency** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 240 W.

### ENVIRONMENTAL AND SAFETY

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: −25°C to +70°C.

**Altitude** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 446 | 17.6 |
| Height | 152 | 6.0 |
| Depth | 540 | 21.3 |
| **Weights** | **kg** | **lb** |
| Net (without accessories) | 15.5 | 34.0 |

## ORDERING INFORMATION

**390AD** Programmable Digitizer **$11,400**

**Includes:** Power cord (161-0066-00); two 4 A fast-blow fuses (159-0017-00); GPIB cable (012-0630-03); 390AD Programming Aid (070-4467-00); operator manual (070-4450-00).

**Option 10** — Rackmount 390AD. **+$250**

**Utility Software**

For 390AD/4041. Order 062-6959-01 **$150**

For 390AD/4052A. Order 062-6960-01 **$150**

See page 297 for description and ordering information.

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

The 620 monitor is recommended for use with the 390AD.

## OPTIONAL ACCESSORIES

**GPIB Cable** — Low EMI.

1m. Order 012-0991-01 **$135**

2m. Order 012-0991-00 **$150**

4m. Order 012-0991-02 **$175**

For floating measurements order A6902B Isolator. See page 437 for complete description. Contact your local sales engineer for details.

**Recommended Probes** — See page 426.

**Service Manual** — To order, contact your local sales office.

The SONY®/TEKTRONIX® 390AD is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 390AD is available from Tektronix, Inc., its marketing subsidiaries and distributors.

# 5223

GPIB IEEE-488 The 5223 Option 10 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Digital Storage (with 5B25N)**

**10 MHz Bandwidth Repetitive Store (Up To 1 GHz with a Sampling Plug-In)**

**100 kHz Bandwidth Single Shot Store**

**Pretrigger**

**10 Bit Vertical Resolution**

**Stored X Versus Y Display**

**Roll Mode**

**X-Y Plotter Output with Penlift**

The Tektronix 5223 Digitizing Oscilloscope has a real-time bandwidth of 10 MHz. It is capable of displaying real-time and stored waveforms simultaneously (four real-time waveforms and four stored waveforms, if dual channel amplifier units are used); the real-time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of ten, using front-panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front-panel display function. The roll mode is useful for viewing low frequency signals. Rear-panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000 Series plug-in units; the flexibility of the plug-in feature, and variety of plug-in units available, allows the system to be used for many measurement applications. The digital storage functions can only be accessed or enabled by using the 5B25N Time Base.

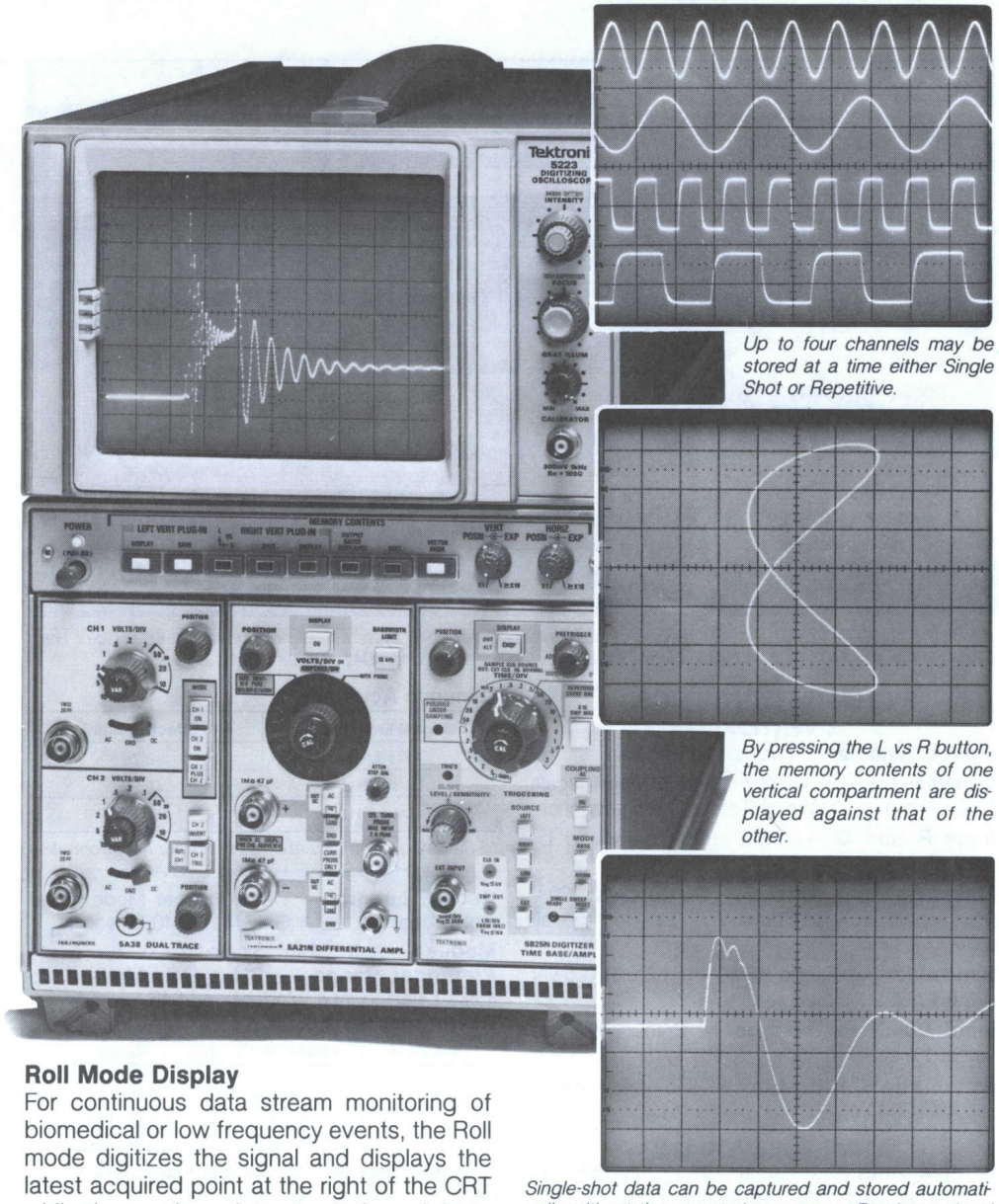
### Display and Save Functions

The Display buttons allows digitization of signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs, or until the Save button is pushed. The Save buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

### L vs R Display

This function displays the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right defines the horizontal axis.

Since the X-Y display is from memory, the real-time sweep is still in the standard Y-time format and may be displayed simultaneously.




*Up to four channels may be stored at a time either Single Shot or Repetitive.*

*By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.*

*Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.*

### Roll Mode Display

For continuous data stream monitoring of biomedical or low frequency events, the Roll mode digitizes the signal and displays the latest acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip chart recorder. Roll mode is available on the sweep range of 5 s/div to 0.1 s/div.

### Vector Display

When Vector Display is selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data and reduces interpretation errors.

### Output Saved Displays

When pressed, an analog output of the displayed/saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

### Display Out Speed Control (Rear Panel)

The Display Out Speed control adjusts the X-Y plotter output speed to compensate for differences in plotter speeds and response.

## CHARACTERISTICS

### VERTICAL REAL TIME SYSTEM

**Channels** — Two plug-in compartments; compatible with 5000 Series plug-ins.

**Mainframe Bandwidth** — 10 MHz with 5A38, 5A45 or 5A48.

**Mainframe Step Response** — 35 ns.

**Chop Mode** — 100 chopped segments/div unexpanded with 5B25N Time Base.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL REAL TIME SYSTEM

**Channel** — Single compartment compatible with 5000 Series time bases and amplifiers. 5B25N must be used in storage modes.

**Fastest Calibrated Sweep Rate** — 20 ns/div.

**X-Y Mode** — <2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

### DIGITAL STORAGE (WITH 5B25N)

**Vertical Resolution** — 10 bits (100 pts/div unexpanded).

**Display Memory Size** — 1 k points/vertical compartment, shared by multiple trace plug-ins.

**Sample Rate** — Maximum of 1 MS/s (1 μs/pt). Actual sample rate depends on time base setting.

**Fastest Single Shot Sweep Speed** — 100 μs/div.

**External Clock In** — Maximum of 1 MS/s (1 μs/pt). TTL compatible.

**Equivalent Time Bandwidth** — 10 MHz.

**Acquisition Window** — ±4 div vertically and ±5 div horizontally from center screen.

**Accuracy** — Determined by plug-ins. Refer to plug-in specifications.

**X-Y** — (Left vs right single channel mode only excluding 100 μs/div sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400 Series vertical plug-ins.

### MEMORY CONTROLS

**Display and Save** — Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector mode, Horizontal and Vertical positioning, and expansion (≥10:1).

**Data Out** — Analog voltage of stored signal. 200 mV/div ±5%. Output rate variable with rear panel control. Pen lift available on rear panel (normally open).

### OUTPUT/INPUTS

**Plug-in Signal Outputs** — Left, Right Vertical, Horizontal Compartments: 50 mV/div ±5% from 50 Ω. Left, Right Vertical Compartments: Dc ≥10 MHz. Horizontal Compartment: Dc ≥7 MHz.

**Time Base Gate** — TTL compatible, positive going.

**Remote Single Sweep Reset** — Rear panel BNC closure to ground resets sweep.

**External Z-Axis Input** — Usable, dc ≥5 MHz voltage swing of 5 V will fully modulate beam dc ≥1 MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).

**Calibrator** — Voltage Output: Squarewave, positive going from ground. Amplitude is 300 mV ±1%. Current Output: 3 mA ±1% available through calibrator output with optional BNC to current loop adaptor.

### CRT AND DISPLAY FEATURES

**CRT** — 8 x 10 div with 1.22 cm/div. Internal illuminated graticule.

**Phosphor** — GH (P31) standard.

**Acceleration Potential** — 15 kV.

**Camera Power** — Compatible with Tektronix C-59 Camera.

### POWER REQUIREMENTS

**Line Voltage Range** — 90 V to 117 V, 102 V to 132 V, 191 V to 249 V, 204 V to 250 V maximum.

**Line Frequency** — 48 Hz to 62 Hz (48 Hz to 440 Hz, Option 05).

**Maximum Power Consumption** — 145 W at 120 V, 60 Hz.

### OPTIONS

**Option 05 Line Frequency Change (48 Hz to 440 Hz)** — Converts the R5223 to 48 Hz to 440 Hz operation.

**Option 10 GPIB Interface** — For I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through the interface for BINARY or ASCII.

**I/O Records** — Waveforms.

**Device Address** — Selectable via rear panel switch.

**Talk/Listen** — Full bi-direction transfer of waveforms plus remote manipulation of storage controls.

**Talk Only** — Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

### GPIB INTERFACE

Interface Function Subsets Implemented:

| | |
|---|---|
| SH1 | Complete source handshake |
| AH1 | Complete acceptor handshake |
| T5 | Talker function |
| L4 | Listener function |
| SR1 | Complete service request capability |
| RL2 | Remote/local capability |
| DC1 | Complete device clear capability |
| PP0 | No parallel poll |
| DT0 | No device trigger capability |
| C0 | N controller function |

### PLUG-IN COMPATIBILITY

All 5000 Series plug-ins are compatible in the standard oscilloscope display mode. The 5L4N, 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital storage operation. The 5A14N is not recommended for use in storage mode.

**Dimensions and Weights** — See page 240.

## 5B25N Digital Time Base

**Bi-Slope Triggering**

**20 ns/div to 5 s/div Calibrated Time Base**

**Triggering to 15 MHz**

The 5B25N is designed specifically for use in the 5223 Digital Storage Oscilloscope. Pretrigger is only available with the 5223. However, the standard analog sweep features including Bi-Slope Triggering and X10 Mag are compatible with 5400 Series mainframes.

### CHARACTERISTICS

**Modes** — Auto, Normal, Single Sweep.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

**External Trigger Input** — Maximum input voltage is 350 V-peak. Input R and C is 1 MΩ paralleled by ≈24 pF.

**External Horizontal Input** — Deflection factor is 50 mV/div ±3%. Dc coupled bandwidth is dc to 2 MHz.

**Sweep Rate** — 0.2 μs/div to 5 s/div in 24 calibrated steps(1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

### TRIGGERING

| Slope | Frequency Range | Minimum Signal Required | |
|---|---|---|---|
| | | Internal | External |
| + or − | Dc to 1 MHz | 0.4 div | 50 mV |
| | 1 MHz to 15 MHz | 0.6 div | 200 mV |
| ± (Bi-Slope) | Dc*1 to 1 MHz | ±0.5 div | ±50 mV |

*1 *30 Hz when ac coupled.*

**Bislope Triggering** — Will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope is selected.

### CHARACTERISTICS
### (WHEN USED WITH THE 5223 MAINFRAME)

**Accuracy**

| Time/Div | Sweep*1 | Digitized*2 | Digitized to Real Time*3 |
|---|---|---|---|
| 50 μs/div to 0.2 μs/div | 3% | 3% | 3% |
| 1 s/div to 0.1 ms/div | 3% | 3% | 3% |
| 2 s/div and 5 s/div | 4% | 3% | 4% |

*1 *Accuracy is specified over the center eight graticule divisions, in 5223 or 5400 Series oscilloscopes. Derate accuracy by 1% for 0°C to +50°C, or when using X10 magnifier.*

*2 *Digitized signal accuracy is specified over center eight graticule divisions in 5223 Oscilloscope, excluding first 200 ns or 0.2 div of each waveform.*

*3 *The digitized signal will match the real time signal within the specified tolerance.*

**Pretrigger** — For viewing events that occur prior to the trigger and is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s/div to 0.1 ms/div.

**Possible Undersampling Indicator** — To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.

**Sampling Rate** — For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.

**Repetitive Store** — For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50 μs/div to 0.2 μs/div.

**External Clock Input** — Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

### ORDERING INFORMATION

**5223** Digitizing Oscilloscope **$5,870**

**Includes:** Power cord (161-0066-00); instruction manual (070-2933-00).

**R5223** Rackmount **$6,045**

**Includes:** Instruction manual (070-2933-00).

#### OPTIONS

**Option 05** — Line Freq Change (R5223 Only). **+$210**

**Option 10** — GPIB Interface. **+$790**

#### CONVERSION KITS

**Rackmount-to-Cabinet** — Order 040-0975-01 **$275**

**Cabinet-to-Rackmount** — Order 040-0976-04 **$375**

**Adds GPIB Interface to Standard 5223** — Order 040-0996-01 **$1,160**

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

**Option A2** — UK 240 V/13 A, 50 Hz.

**Option A3** — Australian 240 V/10 A, 50 Hz.

**Option A4** — North American 240 V/15 A, 60 Hz.

**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**5B25N** Time Base **$970**

**Includes:** Instruction manual (070-2814-00).

### OPTIONAL ACCESSORIES

**Recommended Cart** — The K213 Lab Instrument Cart is recommended for all 5000 Series oscilloscopes. A storage area for plug-ins is available as Option 12.

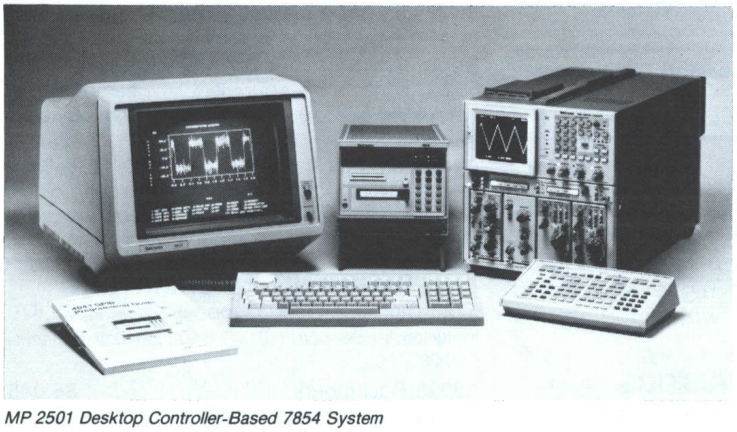
# ACQUISITION/PROCESSING SYSTEMS



## CONTENTS

System Products ..... 330
Software ..... 331
Measurement Packages ..... 332
Measurement System ..... 337

*MS 3101 Computer-Based 7912AD System*



*MP 2501 Desktop Controller-Based 7854 System*

## Precise automatic waveform measurements for demanding applications in research, design, manufacturing and quality assurance

### Automatically save hours, days, even months of work

Tektronix measurement systems are specially designed to handle the increasingly complex, expensive, and time-consuming task of waveform characterization.

They're the first measurement systems to offer all the power and flexibility of oscilloscope acquisition, which may be coupled with programmable stimulus sources for fully automatic analysis. They're the first systems to feature signal processing software with extensive control over instrumentation, waveform manipulations, and graphic display.

### Compatibility

Tektronix measurement systems provide system compatibility that allows configuration for many types of test and measurement applications. This gives you the flexibility of selecting specialized instruments, integrating them easily and broadening the application potential of your automated testing unit as your requirements grow.

### System Building Blocks

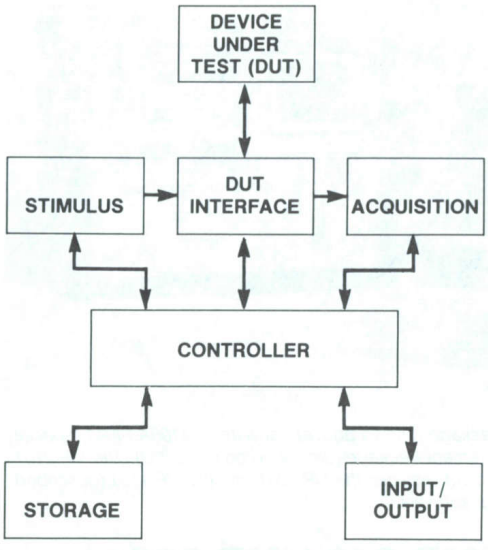
No matter whether your application is in scientific research, engineering design or automated manufacturing and quality control, Tektronix provides for each of the functions that comprise virtually every measurement system.

### Systems that put you in charge.

### Increase Productivity

Tek measurement systems combine state-of-the-art waveform acquisition capabilities with computer processing and software control. They automatically capture the signals you need, make the measurements you want, then display, store and document your results. Projects are more likely to be completed on time and within budget. We provide each of the major functions that comprise a measurement system.

From today's research and development tasks to tomorrow's production testing, Tek systems give you all the capabilities needed to characterize your waveforms quickly, efficiently, and accurately.




### Device Under Test (DUT)
The device that is being tested by the system. The system provides stimulus to the DUT and acquires the results from the test.

### Stimulus
Stimulus units, including function generators, signal generators and other sources, provide known control signals to drive the device under test through normal operation patterns or into boundary conditions for performance limits testing.

### DUT Interface
The DUT Interface provides a path from the stimulus and acquisition equipment and the Device Under Test. Tektronix provides a number of GPIB compatible products for DUT interfacing.

### Acquisition
Tek's growing family of GPIB-compatible waveform digitizers offers the ability to capture signals ranging from seconds to picoseconds in duration, with bandwidths up to 14 GHz. Plus, compatibility with a broad range of 7000 Series plug-ins provides an added dimension of measurement flexibility. Tektronix provides a wide range of GPIB compatible test equipment for measuring an acquired signal.

### Processing
Tek minicomputer systems built around the DEC MICRO/PDP-11*[1] are designed to handle larger amounts of data and offer considerable flexibility in peripheral selection, processing power and speed, software modularity and extended memory. Systems built around the Tek 4041 feature benchtop convenience with powerful analytical and instrument control capabilities.

### Mass Storage
In the form of disk or magnetic tape, mass storage provides permanent storage of raw or processed data for later retrieval, and can also be used to store the test programs.

### Input/Output Devices
Keyboards and keypads on terminals, controllers and some instruments provide convenient access to the system.
Graphics terminal and hard copy units provide alphanumeric and graphic presentation of data and programs as well as permanent documentation. Because the quality of the solution is often dependent on the quality of the display, you gain additional advantage by Tek's leadership in high-resolution, reliable graphic and alphanumeric displays.

### Software
Tektronix minicomputer controllers can be operated with TEK SPS BASIC, a powerful general purpose programming language which offers convenient control of instruments to acquire, process, store and display waveform data with ease. TEK SPS BASIC combines the advantages of being an interactive language with the high performance of a computer operating system. The Tek 4041 comes with its own version of extended BASIC...providing both the simplicity desired by the beginner and the flexibility and power required by the experienced programmer.

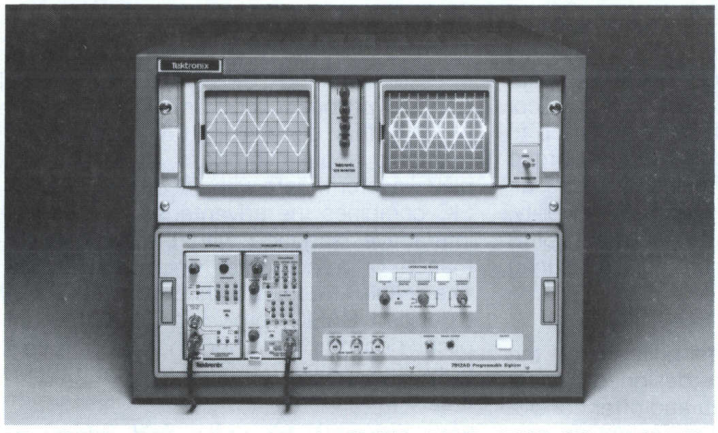
For a complete description and ordering information on SPS BASIC, see pages 301-303.

### The Choice is Yours
Tektronix offers both factory-integrated measurement systems (MS) and preconfigured measurement packages (MP), the latter which you integrate and install yourself. Individual system configurations are summarized in the chart below. They have been selected to provide a high level of performance and permit maximum flexibility... systems that put you in charge.

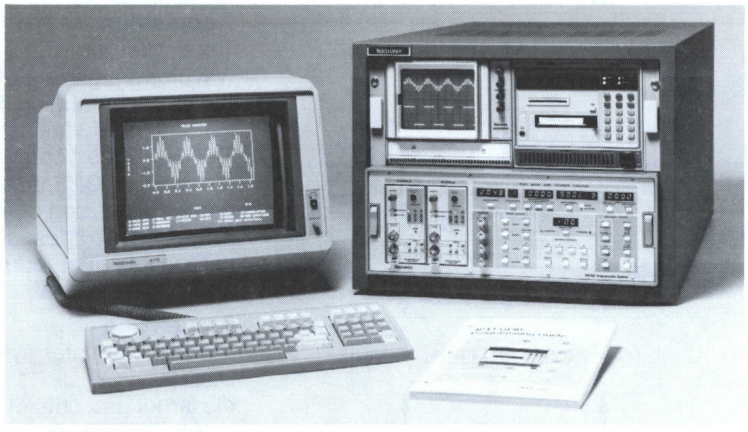
*[1] *DEC and PDP are registered trademarks of Digital Equipment Corporation.*

## INDIVIDUAL SYSTEM CONFIGURATION

| Application | Fastest Single-shot transient digitizer, at highest bandwidth. | High Bandwidth, multi-record, dual-channel digitizer for both single-shot and repetitive signals. | Compact dual-channel signal acquisition, for medium bandwidth repetitive and single-shot signals. | Excellent signal acquisition for repetitive signals, high bandwidth. | Extensive signal acquisition capabilities with signal analysis. | Versatile and compact signal stimulus and acquisition for medium and low speed signals. | Makes critical audio measurements consistently, accurately and quickly. | Extensive measurement capabilities for: high resolution video applications, automatic test and measurement applications, or automatic measurements of moderate speed signals. |
|---|---|---|---|---|---|---|---|---|
| **Acquisition Instrument** | **7912AD** | **7612D** | **7D20T** | **7854** | **2430** | **MI 5010/ MX 5010** | **SG 50101/ AA 5001** | **2465 DVS or 2465 DMS or 2465 CTS** |
| **Your own Controller** | **MP 1101** $38,695 | **MP1201** $35,965 | | | | | | |
| **Compact Controller** Tektronix 4041 with enhanced instrument control and analysis BASIC software | **MP 2101** $51,985 | **MP 2201** $49,415 | **MP 2401** $25,790 | **MP 2501** $29,475 | **MP2601** $15,650 | **MP 2901** $19,890 | **MP2902** $21,770 | **MP2903** $21,760 |
| **Expandable Controller** MICRO/PDP-11 with TEK SPS BASIC control and analysis software | **MS 3101** $71,765 | **MS 3201** $68,335 | — — | — — | — — | — — | — — | — — |



*MP 1101 (shown above) consists of a 7912AD, 7A16P, 7B90P, 620 and 634. The MP1201 (not shown) consists of a 7612D, two 7A16Ps, and a 620.*



*The MP 2201 Measurement Package (shown above) consists of 4105A, 4041, special software, plus MP 1201 Measurement Package (described on page 332). The MP 2101 Measurement Package (not shown) replaces the MP 1201 with the MP 1101 (described on page 332) and adds special software.*

# MP 1101/MP 1201

GPIB IEEE-488 The MP 1101 and MP 1201 comply with IEEE Standard 488-1975.

**MP 1101 Features:**

**Highest Bandwidth Single-Shot Acquisition (up to 500 MHz at 10 mV/Div, Nonprogrammable)**

**Fully Programmable up to 200 MHz Bandwidth**

**Codes and Formats Features**

**MP 1201 Features:**

**Dual-Channel Signal Acquisition (up to 200 MS/s Sampling Speed). Signal Bandwidth of 80 MHz**

**Selectable Record Length from 256 Words to 2048 Words Each Channel**

**Codes and Formats Features**

The MP 1101 is based on the high-bandwidth 7912AD Programmable Transient Digitizer. It is excellent for any signal measurement requirement needing single-shot acquisition (either for computer or operator interpretation of extremely fast signals such as laser-research and high-energy physics phenomena). Without a controller, the MP 1101 may be used as a high bandwidth storage oscilloscope.

The MP 1101 includes a 7912AD Programmable Transient Waveform Digitizer, 7A16P Programmable Amplifier, 7B90P Programmable Time Base, 620 General Purpose X-Y Monitor, 634 High Resolution Video Monitor, and mounting hardware, cables and accessories, and cabinet (shipped unassembled).

In order to achieve 500 MHz bandwidth, a nonprogrammable 7A19 or 7A29 can be substituted for the 7A16P.

The MP 1201 is based on the 7612D Dual Channel Programmable Waveform Digitizer. It features very flexible record partitioning during acquisition, allowing up to 13 changes in sampling rate per record for optimum signal resolution and best memory utilization.

The MP 1201 includes a 7612D dual channel Programmable Waveform Digitizer, two 7A16P Programmable Amplifiers, a 620 General Purpose X-Y Monitor, and the necessary mounting hardware, cables and accessories.

## CHARACTERISTICS

The following characteristics are the same for the MP 1101 and MP 1201 unless otherwise indicated.

### ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature** — 0°C to +40°C (+32°F to +104°F).

**Thermal Output** — Approximately 1550 BTU/hr.

**Operating Altitude** — 4600 m maximum (15,000 ft).

### POWER REQUIREMENTS

**Standard Operating Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — 450 W (nominal).

### PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

## ORDERING INFORMATION

| | |
|---|---|
| **MP 1101** Programmable Digitizer Measurement Package | **$38,695** |
| **Option 01** — Delete Plug-ins. | **–$5,280** |
| **MP 1201** Programmable Digitizer Measurement Package | **$35,965** |
| **Option 01** — Delete Plug-ins. | **–$4,790** |

**For additional information on the alternative mounting configurations contact your local Tektronix Sales Office and ask for a sales engineer.**

# MP 2101/MP 2201/ MP 2401

GPIB IEEE-488 The MP 2101 and MP 2201 comply with IEEE Standard 488-1975. The MP 2401 complies with IEEE Standard 488-1978. All three comply with Tektronix *Standard Codes and Formats*.

**High-Performance Waveform Acquisition**

**Fully Programmable over IEEE Standard 488 Bus for System Oriented Operation**

**Enhanced BASIC Language—Resident 4041 BASIC with Numerous Extensions**

**MP 2101 Features:**

**Ultra High-Speed Single Shot Digital Storage Capability**

**Up to 200 MHz Bandwidth at 10 mV/Div and Full Programmablility with 7A16P Vertical Plug-in**

**Up to 500 MHz Bandwidth at 10 mV/Div with 7A19 Vertical Plug-in**

**Codes and Formats Features**

**MP 2201 Features:**

**200 Megasamples Per Second Maximum Rate, Each Channel**

**Two Vertical Channels. Two Independent Time-Bases**

**Eight-Bit Resolution**

**Codes and Formats Features**

**MP 2401 Features:**

**7D20T Programmable Digitizer**

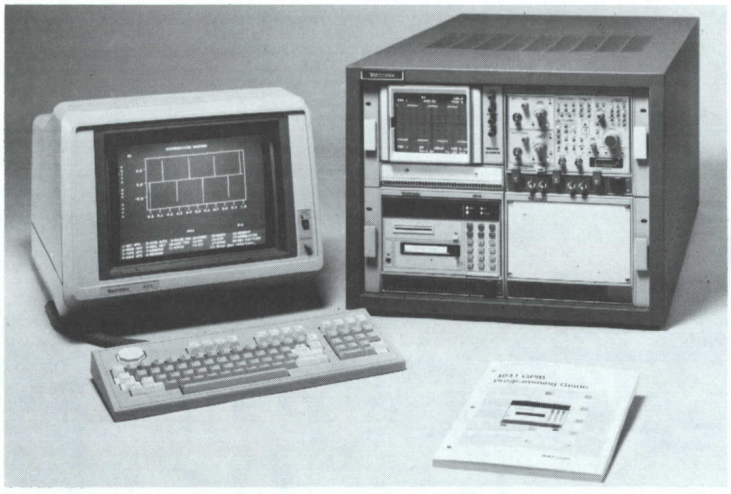
**70 MHz Bandwidth for Repetitive Signals**

**10 MHz Single-Shot Bandwidth**

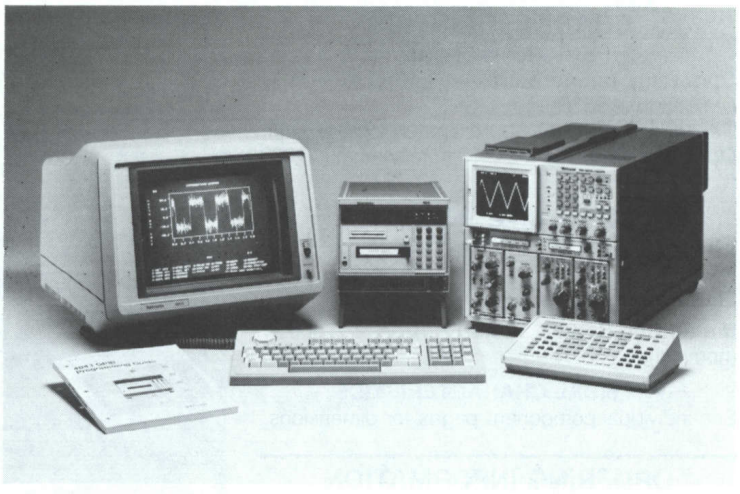
**Two Channels Simultaneous Acquisition**

**Store up to Six Independent Waveforms**

**Enveloping and Signal Averaging**



*The MP 2401 Measurement Package consists of a display monitor, 7D20T, 4041, 4105A, and software.*



*MP 2501*

The MP 2101 provides the highest bandwidth for single-shot applications, up to 500 MHz in a nonprogrammable configuration (substituting a 7A19 or 7A29 vertical amplifier for the 7A16P), as well as built-in signal averaging. The MP 2201 provides true dual-channel. 200 MS/s digitizing with up to 80 MHz analog bandwidth. The MP 2201 can also be tailored for different signal characteristics using the 7000 Series plug-ins.

The MP 2101 Measurement Package includes the MP 1101 as its acquisition kernel; the MP 2201 Measurement Package includes the MP 1201. Added to both packages are the 4041 System Controller, 4105A Color Graphics Terminal, special acquisition and analysis software, and cabinet (shipped unassembled). The 4695 Color Graphics Copier is a popular option.

The MP 2401 Package is based on the 7D20T Programmable Digitizer, and provides an ideal general-purpose signal analysis configuration. It combines dual-channel signal acquisition and built-in storage with inherent enveloping, averaging, cursor measurements, and prestored waveform comparison abilities.

In addition to one 7D20T, the standard package includes a 4041 System Controller, 4105A Color Graphics Terminal, 620 General Purpose X-Y Monitor, special MP software, and cabinet (shipped unassembled). An alternative configuration uses a 7D20 installed in a 7000 Series Oscilloscope mainframe. The optional 4695 Color Graphics Copier extends the usefulness of the system.

The special MP software included with each of these three packages enables the operator to acquire, analyze (min/max, histogram), process (correlate, convolve, FFT, etc.), display, and store waveforms from the system terminal via easy-to-use menus. The software is also designed to accommodate multiple digitizers of the same type in each system (up to 28 digitizers per system with optional second IEEE-488 bus).

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).

**Thermal Output** — MP 2101/MP 2201: Approximately 3750 BTU/hr. MP 2401: Approximately 2900 BTU/hr.

**Operating Altitude** — 4600 m maximum (15,000 ft).

### POWER REQUIREMENTS

**Standard Operating Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — MP 2101/MP 2201: 1100 W. MP 2401: 850 W.

### PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

## ORDERING INFORMATION

**MP 2101** Acquisition/Processing Measurement Package **$51,985**

**Option 01** — Delete Plug-ins. **−$5,280**

**MP 2201** Acquisition/Processing Measurement Package **$49,415**

**Option 01** — Delete Plug-ins. **−4,790**

**MP 2401** Acquisition/Processing Measurement Package **$25,790**

### OPTIONS

**Option 10** — Substitute Tektronix 4107A Color Graphics Terminal for 4105A Color Graphics Terminal. See page 67. (MP 2101, MP 2201, MP 2401). **+$3,500**

**Option 20** — Add Tektronix 4695 Color Graphics Hard Copy Unit. See page 77. (MP 2101, MP 2201, MP 2401). **+$1,595**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**For additional information on the alternative mounting configurations contact your local Tektronix Sales Office and ask for a sales engineer.**

# MP 2501

GPIB IEEE-488 The MP 2501 complies with IEEE Standard 488-1975.

**7854 Waveform Processing Oscilloscope**
**Dc to 400 MHz Bandwidth at 10 mV/Div**
**Stores Repetitive Waveforms up to 400 MHz (up to 14 GHz with Sampling Plug-ins)**
**Single Shot Events and Pretrigger up to 50 µs/Div with 7B87 Time Base)**

**Enhanced BASIC Language—Resident 4041 BASIC with Numerous Extensions**

The MP 2501 Acquisition/Processing Measurement Package is based on the Tektronix 7854 Waveform Processing Oscilloscope, and is designed for signal acquisition, analysis, and processing of repetitive waveforms up to 400 MHz, or up to 14 GHZ with optional sampling plug-ins. It provides flexibility for making controller-assisted measurements in fiber optic testing environments, using Tektronix sampling plug-in units.

The MP 2501 includes the 4041 System Controller with Extended 4041 BASIC, a 4105A Terminal, and special MP software. The 4695 Color Graphics Copier is a particularly useful option with this package.

The MP software complements the built-in waveform processing and analysis features of the 7854 with menu-driven functions such as CORRELATE, CONVOLVE, FFT, DIFFERENTIATE, INTEGRATE, and TAPER. The MP software also greatly facilitates the storage and retrieval of waveforms and 7854 programs via mass media. The software can control up to 14 7854s (up to 28 with the optional second IEEE-488 bus).

NEW

GPIB

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).
**Thermal Output** — Approximately 2750 BTU/hr.
**Operating Altitude** — 4600 m maximum (15,000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage** — 115 V (nominal).
**Line Frequency** — 60 Hz.
**Maximum Power Consumption** — 800 W (nominal).

### PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

## ORDERING INFORMATION

**MP 2501** Acquisition/Processing Measurement Package (Order appropriate 7000 Series plug-ins, such as 7A16A, 7B80, and 7B87.) (See pages 213 and 220.) **$29,475**

#### OPTIONS

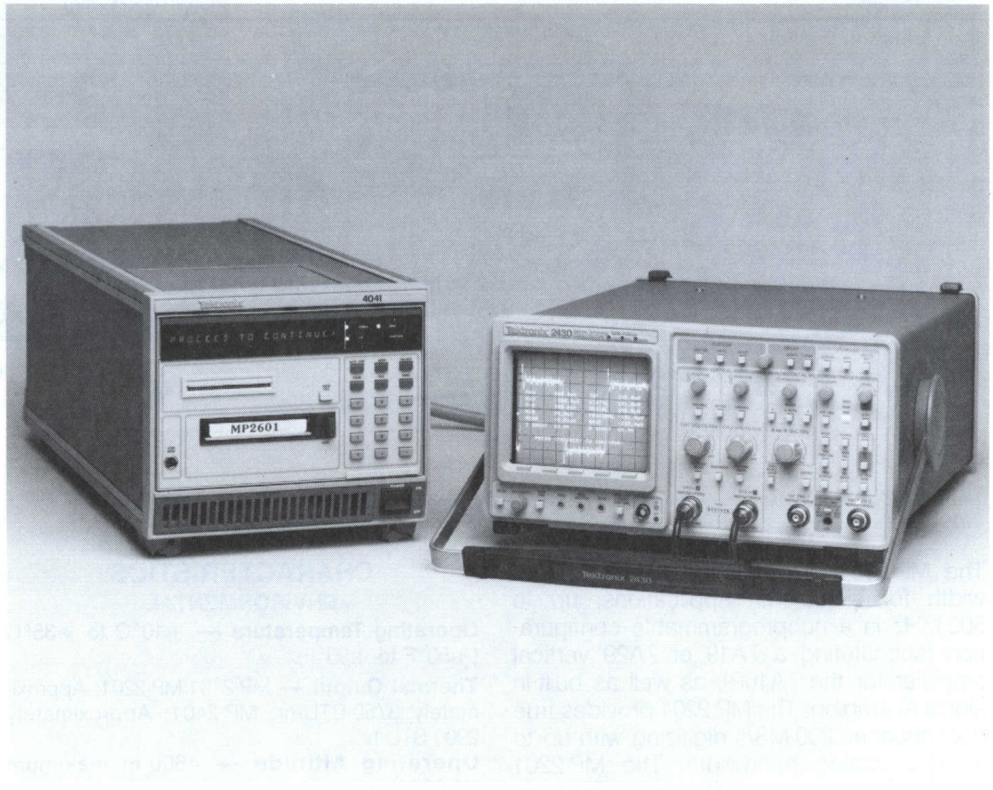
**Option 10** — Substitute Tektronix 4107A Color Graphics Terminal for 4105A Color Display Terminal. See page 67. **+$3,500**

**Option 20** — Add Tektronix 4695 Color Graphics Hard Copy Unit. See page 76. **+$1,595**

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

**Recommended Cart** — (For 7854 and 4041) K213 Option 10 Lab Cart with keyboard drawer for the 7854 and lower shelf for the 4041. See page 424 for a complete description.




# MP2601

GPIB IEEE-488 The MP2601 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**Two Channels Simultaneous Acquisition**

**100 MHz Sample Rate for Single-shot Acquisition**

**150 MHz Bandwidth for Repetitive Signals**

**Envelope Mode for 2 ns Glitch Capture at Any Sweep Speed.**

**Signal Averaging to Pull Signals Out of Noise**

**Extensive Triggering Capabilities**

**Event Capture on Trigger Events or When Signal Exceeds Predefined Limits**

**Data Logging Upon Demand, with Each Trigger Event, or When Signal Exceeds Predefined Limits**

**Extensive Time and Amplitude Measurements**

**Signal Processing and Data Manipulation to Match Measurement Requirements**

**Ease of Use via Menu-Driven Control**

The MP2601 Portable Measurement Package provides extensive signal acquisition capabilities with signal analysis forming a system directed at measurement solutions.

**MP2601 Functions:**

Reference waveform to file transfers (46 files).

Files to reference waveforms transfer

Event Capture

20 parameters on waveforms (top, base, distal, mesial, proximal, min, max, peak to peak, mid, mean, top overshoot, base overshoot, rise, fall, width, duty cycle, period, 1/period, RMS, and area)

Waveform mathematics (add, subtract, multiply, divide, integrate, 2-point differentiation, 3-point differentation, smoothing, FFT, correlate, add scalar, and multiply by scalar).

Application programs

Environmental parameters

The MP2601 consists of a 4041 controller (with a minimum 160 kbytes of memory, signal processing ROM, Utility ROM, and ROM carrier); 2430 Digital Oscilloscope; IEEE-488 Cable, and a S45F601 Software Package.

## ORDERING INFORMATION

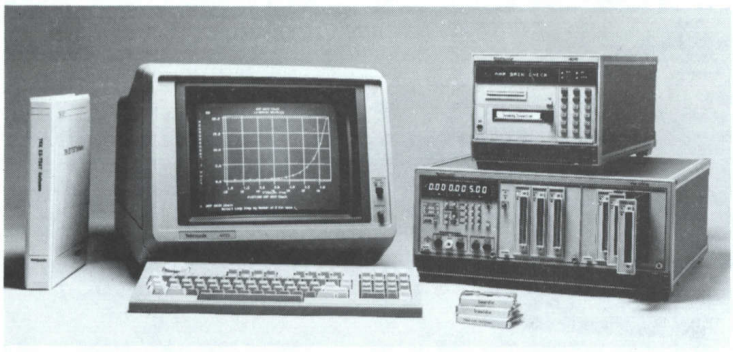
**MP2601** Portable Measurement Package **$15,650**

#### OPTIONS

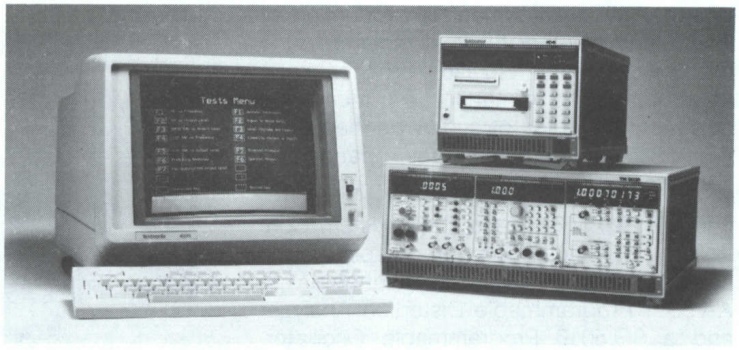
**Option 05** — Video Trigger. **+$1,050**
**Option 11** — Probe Power. **+$165**

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.



MP 2901



MP2902 shown with Option 2H (DC 5010 Programmable Universal Counter/Timer)

# MP 2901

GPIB IEEE-488

The MP 2901 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**A General Purpose IEEE-488 Development System**

**Rapid, Error-Free Software Development by Nonprogrammers**

**Easy Fixturing to the Device-Under-Test**

**Compatible with IEEE Standard 488 Equipment from Most Suppliers**

The MP 2901 overcomes two of the most difficult hurdles in implementing an automated system—writing the test software and interfacing the IEEE-488 system to the unique device under test.

The task of software development is dramatically reduced with TEK EZ-TEST software. This software is a high-level, menu-driven program which allows even nonprogrammers to create test software. The generated BASIC code is error-free and structured (to allow easy long-term maintenance). TEK EZ-TEST is powerful and flexible. It supports "learn mode" found in Tektronix instruments for exceptionally easy instrument set-up. Naturally, TEK EZ-TEST has the ability to accept IEEE-488 instruments from other manufacturers as well. The test programs generated are standalone 4041 BASIC programs so TEK EZ-TEST generated programs can be tailored to meet even the most unique test requirements.

The MI 5010/MX 5010 provide A/D, D/A, digital I/O, scanning, switching, and other functions using high-level commands. With these functions, the task of stimulating/measuring/switching the device-under test and the test instruments is made easy because the MI 5010/MX 5010 handle the interface between the device-under-test and the IEEE-488 bus.

The MP 2901 package includes a 4041 System Controller, 4105A Color Computer Display Terminal, and a TM 5006 six-wide mainframe with MI 5010/ MX 5010 Programmable Multifunction Interface and Extender, and PS 5010 Programmable Triple Power Supply. TEK EZ-TEST® software is utilized for test program generation.

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).

**Operating Altitude** — 4600 m maximum (15,000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — 970 W.

### PHYSICAL CHARACTERISTICS

See individual components pages for dimensions.

## ORDERING INFORMATION

**MP 2901** Incoming Inspection Test Station **$19,890**

### OPTIONS

**Option 03** — Delete MI 5010, MX 5010, PS 5010.*1

**Option 1A** — Add 50M10 A/D Converter Card. **+$895**

**Option 1B** — Add 50M20 D/A Converter Card. **+$910**

**Option 1C** — Add 50M30 Digital I/O Card. **+$495**

**Option 1D** — Add 50M40 Relay Scanner Card. **+$695**

**Option 1E** — Add 50M41 Low Level Scanner Card. **+$995**

**Option 1F** — Add M41A1 Low Level Amplifier. **+$550**

**Option 1G** — Add 50M50 16 k Buffer Memory Card. **+$995**

**Option 1H** — Add 50M70 Development Card. **+$410**

**Option 10** — Substitute 4107A Color Graphics Terminal for 4105A. **+$3,500**

**Option 19** — Add 4644 printer.*1

**Option 2A** — Add TM 5006 Mainframe w/Option 02 & 2 m GPIB Cable. **+$1,275**

**Option 2B** — Add TM 5006 Mainframe w/Option 12 & 2 m GPIB Cable. **+$1,375**

**Option 2C** — Add DM 5010 4.5 Digital Multimeter. **+$2,260**

**Option 2D** — Add FG 5010 20 Hz Function Generator. **+$4,500**

**Option 2E** — Add SG 5010 Oscillator. **+$4,195**

**Option 2F** — Add PS 5010 ±32 V Triple Power Supply. **+$3,050**

**Option 2G** — Add PS 5004 20 V Precision Power Supply. **+$1,850**

**Option 2H** — Add DC 5010 350 MHz Digital Counter. **+$4,485**

**Option 2J** — Add SI 5010 16 Channel, 350 MHz Scanner. **+$2,275**

**Option 2K** — Add MI5010 Multifunction Interface. **+$1,760**

**Option 2L** — Add MX5010 Interface Extender. **+$740**

**Option 2M** — Add DC 5009 135 MHz Digital Counter. **+$2,650**

**Option 20** — Add 4695 Color Graphics Hard Copy Unit. **+$1,595**

**Option 22** — Add Option 01 to 4041 (Second GPIB Interface and second RS-232C port) This option is not available with Option 23.*1

**Option 23** — Add Option 03 to 4041. (Disk Interface and second RS-232C port). This option is not available with Option 22.*1

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

**Option A2** — UK 240 V/13 A, 50 Hz.

**Option A3** — Australian 240 V/10 A, 50 Hz.

**Option A4** — North American 240 V/15 A, 60 Hz.

**Option A5** — Switzerland 220 V/10 A, 50 Hz.

*1 *Contact your local sales office.*

# *NEW* MP 2902

GPIB IEEE-488

The MP 2902 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**Eleven Comprehensive Audio Tests**

**Rapid, Error-Free Test Program Development by Nonprogrammers**

**State-of-the-Art Measurement Performance**

**Software Supports All IEEE Standard 488 Instruments and Provides for Unique Test Requirements**

The MP 2902 Audio Measurements Package makes critical audio measurements consistently, accurately and quickly. The Tektronix Audio Test Program Generator (Audio TPG) produces automated test procedure quickly and easily. This software development tool dramatically simplifies the process of converting manual tests into software. With the Audio TPG, menus guide nonprogrammers through test development. The result is error-free code written in 4041 BASIC. Tests supported in the Audio TPG include: THD vs Frequency, THD vs Output Level, IMD vs Output Level (SMPTE or CCIF), CCIF IMD vs Frequency, Frequency Response, Signal-to-Noise, Level (Voltage and Power), Linearity, and External Stimulus. Provisions are made for the user to add any unique testing requirements which are not directly supported in the Audio TPG.

# TEK OSCILLOSCOPE MEASUREMENT PACKAGE

Whether the environment is production or R & D and whether the test requirement is microphone characterization, broadcast station proof-of-performance, or measuring noise and distortion of audiotype machines, the MP 2902 offers accuracy, speed, and consistency.

The MP 2902 includes a 4041 System Controller, 4105A Color Computer Display Terminal, and a TM 5006 six-wide mainframe with AA 5001 Programmable Distortion Analyzer and a SG 5010 Programmable Oscillator. Tektronix Audio Test Program Generator software is utilized for test program generation.

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — +10°C to +35°C (+50°F to +95°F).

**Operating Altitude** — 4600 M Maximum (15,000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — 970 W.

### PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

## ORDERING INFORMATION

**MP 2902** Audio Measurements Package **$21,770**

**OPTIONS**

**Option 1J** — Substitute AA 5001. Option 02 (CCIR/DIN) for AA 5001. **+$410**

**Option 10** — Substitute 4107A Color Graphics Terminal for the 4105A Color Graphics Terminal. **+$3,500**

**Option 11** — Substitute 4106A Color Graphics Terminal for 4105A Color Graphics Terminal. **+$2,500**

**Option 19** — Adds 4644 Dot Matrix Printer. **+$1,350**

**Option 2H** — Adds DC 5010 Programmable Universal Counter/Timer. **+$4,485**

**Option 20** — Adds 4695 Color Graphics Printer. **+$1,595**

**Option 22** — Adds Option 01 to 4041 (Second GPIB Interface and second RS-232C port). This option is not available with Option 23. **+$1,600**

**Option 23** — Adds Option 03 to 4041 (Disk Interface and second RS-232C Port). This option is not available with Option 22. **+$1,400**

**Option 24** — Adds 4926 Option 25 (10 Mbyte Hard Disk and Dual 5.25 inch Flexible Disk). Requires Option 23. **+$5,800**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

*MP 2903*

# *NEW* MP 2903

GPIB IEEE-488 The MP 2903 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats.*

**2465 DVS Oscilloscope Software Development System**

**Rapid, Error-Free Test Program Development by Nonprogrammers**

**300 MHz Bandwidth at Probe Tip**

**Counter/Timer/Word Recognizer**

**4.5 Digit DMM**

**TV Waveform Measurements**

**Compatible with IEEE Standard 488 Equipment from Most Suppliers**

The MP 2903 Oscilloscope Measurement Package ensures rapid implementation of an automated 2465 DVS based measurement system. Whether the driving force for automating is reduced cost, improved documentation, or test repeatability, the MP 2903 can aid in quickly automating your unique application.

The task of software development is dramatically reduced with TEK EZ-TEST software. This software is a high-level, menu-driven program which allows even nonprogrammers to create test software. The generated BASIC code is error-free and structured (to allow easy long-term software maintenance). It supports "learn mode" found in Tektronix instruments for exceptionally easy instruments set-up. Naturally, TEK EZ-TEST has the ability to accept IEEE-488 instruments from other manufacturers. The test programs generated area standalone 4041 BASIC programs so programmers can tailor the TEK EZ-TEST generated programs to even the most unique test requirements.

The 2465 DVS Oscilloscope provides extensive measurement capabilities including rise/fall time, pulse width, duty cycle, phase shift, propagation delay, delay time, delta time, frequency and period as well as voltage, resistance, and current measurements—with accuracies previously found only in stand-alone counters and multimeter.

This package includes a 4041 System Controller, 4105A Color Computer Display Terminal and a 2465 DVS Oscilloscope. TEK EZ-TEST software is utilized for test program generation.

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature** — 10°C to 35°C (50°F to 95°F).

**Operating Altitude** — 4600 m maximum (15,000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage** — 115 V (nominal).

**Line Frequency** — 60 Hz.

**Maximum Power Consumption** — 440 W.

### PHYSICAL CHARACTERISTICS

See individual component pages for dimensions.

## ORDERING INFORMATION

**MP 2903** Oscilloscope Measurement Package **$21,760**

**OPTIONS**

**Option 08** — Substitute 2465 DMS for 2465 DVS. **−$800**

**Option 09** — Substitute 2465 CTS for 2465 DVS. **−$2,050**

**Option 10** — Substitute 4107A Color Graphics Terminal for 4105A. **+$3,500**

**Option 11** — Substitute 4106A Color Graphics Terminal for 4105A. **+$2,500**

**Option 20** — Adds 4695 Color Graphics Printer. **+$1,595**

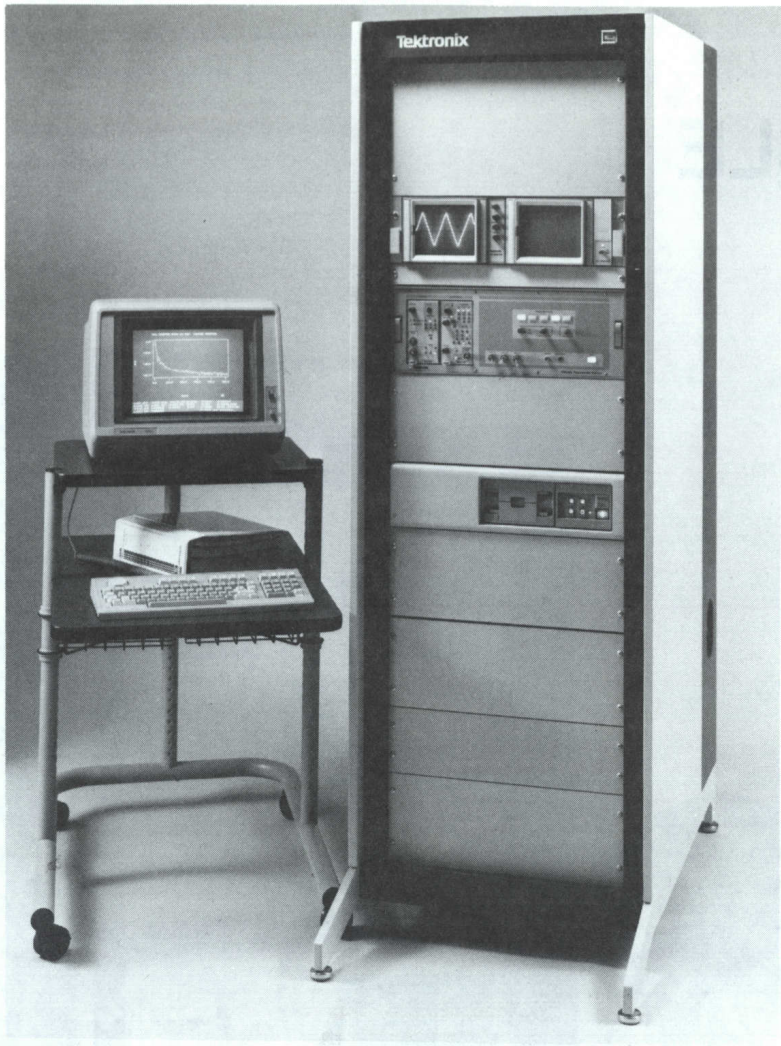
**Option 22** — Adds Option 01 to 4041 (Second GPIB Interface and second RS-232C port). This option is not available with Option 23. **+$1,600**

**Option 23** — Adds Option 03 to 4041 (Disk Interface and second RS-232 port). This option is not available with Option 22. **+$1,400**

**Option 24** — Adds 4926 Option 25 (10 Mbyte Hard Disk with Dual 5.25 Inch Flexible Disk Drive). Requires Option 23. **+$5,800**

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.




*Shown above is the MS 3101. The MS 3201 replaces the 7912AD Programmable Digitizer with a 7612D Programmable Waveform Digitizer (see inset). Cart not included.*[1]*

# MS 3101/MS 3201

GPIB IEEE-488 The MS 3101 and MS 3201 comply with IEEE Standard 488-1975.

**High-Performance Waveform Acquisition**

**Control and Data-Analysis Package**
- **Powerful Waveform and Array Processing**
- **128 k Words of Computer Memory Supported**
- **Flexible Real-Time Instrument Control**
- **Extensive String Processing**
- **Comprehensive Graphics**

**Codes and Formats Features**

*[1] For specifications and ordering information see page 83.*

**MS 3101 Features:**

**Ultra High-Speed Single Shot Digital Storage Capability**

**Up to 200 MHz Bandwidth at 10 mV/Div with Full Programmability**

**Up to 500 MHz Bandwidth at 10 mV/Div with a 7A19 Vertical Plug-in**

**MS 3201 Features:**

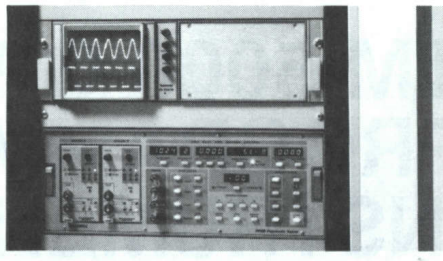
**200 Megasamples Per Second Maximum Rate, Each Channel**

**Two Separate Vertical Channels. Two Independent Time Bases**

**Eight Bit Resolution**

The MS 3101 and MS 3201 Acquisition/Processing Measurement Systems are self-contained signal acquisition and waveform processing systems. The MS 3101 is based on the Tektronix 7912AD Programmable Digitizer for excellent single-shot acquisition capability. The MS 3201 is based on the Tektronix 7612 Programmable Digitizer for excellent dual-channel acquisition capability. Both utilize the 119-1834-00 (DEC MICRO/PDP-11) Instrument Controller which use the MP 1101 Measurement Package or 1201 Measurement Package for the acquisition kernel.

Both include a 10 megabyte Winchester disk and dual 5¼ inch flexible diskette drives, contained in a compact 5¼ inch controller height configuration.



*Shown above is the 7612D contained in the MS 3201. The 7912AD and 7612D are shown and described separately on pages 324 and 321 respectively.*

They can control up to 56 GPIB instruments, using the TEK SPS BASIC control, data reduction, and graphic display language.

Fully assembled and tested in a full bay cabinet, they also include a 4105A Color Display Terminal. The color hard copy unit and cart are optional.

## CHARACTERISTICS

### ENVIRONMENTAL

**Operating Temperature —** Ambient Air: Nominal is +20°C. Range is +16°C to +24°C. Forced Cooling Air: Nominal is +18°C. Range is +13°C to +22°C. Thermal Shock: <1°C/minute short term. <5°C/hr long term.

**Humidity —** Nominal: 45% relative humidity, noncondensing. Range: 40% to 60% relative humidity, noncondensing.

**Thermal Output —** Approximately 3750 BTU/hr.

**Operating Altitude —** −76 m to 2400 m maximum (−250 ft to 8000 ft).

### POWER REQUIREMENTS

**Standard Operating Line Voltage —** 115 V (nominal).

**Line Frequency —** 60 Hz.

**Maximum Power Consumption —** 1100 W (nominal).

### PHYSICAL CHARACTERISTICS

| Cabinet Dimensions | mm | in |
|---|---|---|
| Height | 1833 | 72.2 |
| Width | 616 | 24.3 |
| Depth | 1070 | 42.4 |

| 4105A | Console | | Keyboard | |
|---|---|---|---|---|
| Dimensions | mm | in | mm | in |
| Height | 353 | 13.9 | 41 | 1.6 |
| Width | 419 | 16.5 | 423 | 16.6 |
| Depth | 492 | 19.5 | 180 | 7.0 |

## ORDERING INFORMATION

**MS 3101** Acquisition/Processing Measurement System **$71,765**

**MS 3201** Acquisition/Processing Measurement System **$68,335**

### OPTIONS

**Option 01 —** Delete Plug-ins
(MS3101) **−$5,280**
(MS3201) **−$4,790**

**Option 10 —** Substitute Tektronix 4107A Color Graphics Terminal for 4105A Color Graphics Terminal. (See page 67.) **+$3,500**

**Option 20 —** Add Tektronix 4695 Color Graphics Copier. (See page 76.) **+$1,595**

**Customer Training is available on this product. See page number 452 for futher details.**

# TM 5000 GPIB PROGRAMMABLE INSTRUMENTS

## CONTENTS


DC 5010 Digital Counter ..... 340
DC 5009 Digital Counter ..... 342
DP 501 Digital Prescaler ..... 343
DM 5010 Digital Multimeter ..... 344
FG 5010 Function Generator ..... 345
PS 5004 Power Supply ..... 346
PS 5010 Power Supply ..... 347
AA 5001 Distortion Analyzer ..... 348
SG 5010 Programmable Oscillator ..... 348
MI 5010 Programmable Multifunction Interface ..... 350
MX 5010 Programmable Multifunction Interface ..... 350
SI 5010 Programmable Scanner ..... 354
TM 5003 Power Module Mainframe ..... 355
TM 5006 Power Module Mainframe ..... 355
System Accessories ..... 356 & 390


### Designed for Configurability; for Programming Ease; for Productivity.

Test and measurement setup has never been this friendly, has never been this fast. With Tek's line of TM 5000 programmables, you can continue to build on the concept of configurability. You can link together customized, automated test packages with the same plug-in, pull-out ease as found in our TM 500 manual instrument line. The TM 5000 IEEE Standard 488 compatible, fully programmable instruments are among the friendliest and fastest to integrate you can buy.

The 350 MHz DC 5010 Universal Counter/Timer is the state-of-the-art in high performance universal counter/timers. Its 1 ps time interval averaging resolution is unmatched for the industry.

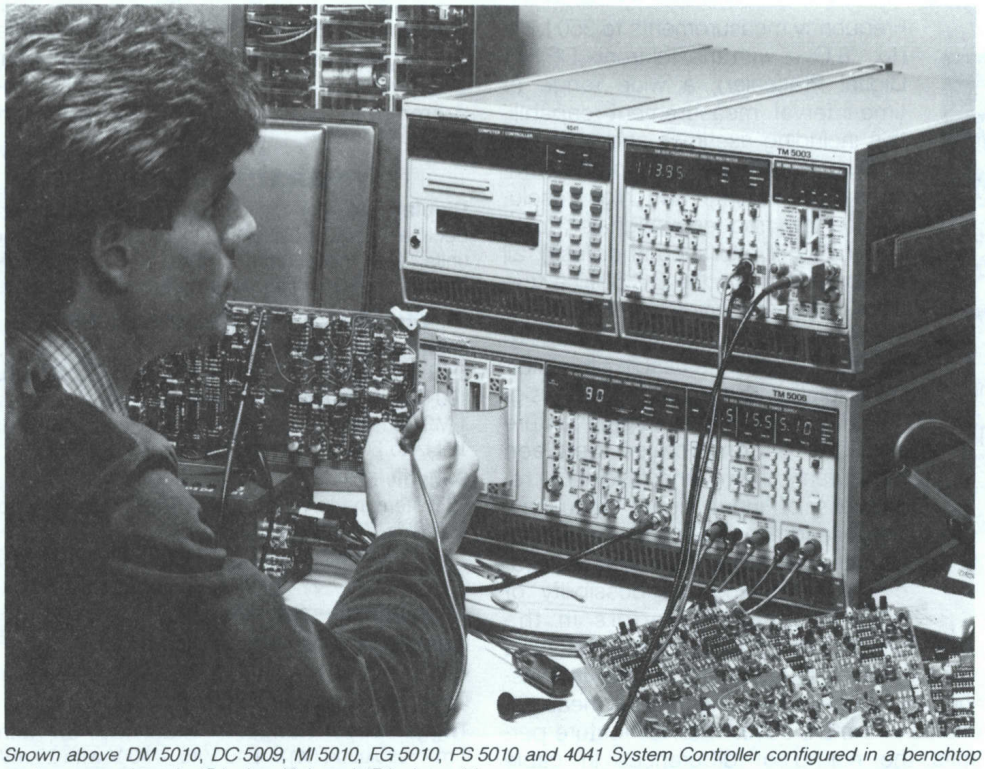
For lower speeds, the 135 MHz DC 5009 Universal Counter/Timer is the industry's lowest cost, fully programmable counter/timer. It provides all of the functions of the higher-performance DC 5010 except rise/fall and null.

The DP 501 Digital Prescaler extends the frequency measurement capability of the DC 5010 and DC 5009 to 1.3 GHz under program control.

The DM 5010 Digital Multimeter measures dc and true RMS ac volts, ohms, and provides a diode test function. Internal math capabilities include averaging, nulling, offset, scaling, dB, and HI/LO/Pass sorting.

The FG 5010 Function Generator features variable symmetry throughout the full 20 MHz bandwidth of the instrument. Other important functions include counted burst, phase lock, and the ability to store and recall ten complete front panel setups.

The PS 5010 Power Supply, with its three separately programmable supplies, provides the most widely used voltages, all under complete program control, including current limit, source on/off, and extensive status reporting.



*Shown above DM 5010, DC 5009, MI 5010, FG 5010, PS 5010 and 4041 System Controller configured in a benchtop system approximately 15 inches high and 17 inches wide.*

The PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistors, ICs, and other semiconductor and hybrid circuits. The actual values of the output voltage, output current, and current limit may be read directly from the 4½-digit front panel display or are available over the GPIB.

The AA 5001 Programmable Distortion Analyzer and SG 5010 Programmable Oscillator are the world's first truly high-performance programmable audio test instruments. Together, they provide unequaled capability covering the full range of standard audio testing—THD, IMD, (SMPTE, DIN, CCIF difference tone), gain/loss, and signal-to-noise ratio. The AA 5001 is fully automatic in each of its operating modes—no tuning, no nulling, no level setting, no range changing—even with a remotely located signal source.

A complete range of system control and signal routing capabilities are available with the MI 5010 Multifunction Interface and MX 5010 Multifunction Interface Extender and the SI 5010 350 MHz Programmable Scanner. Function cards currently available for the MI 5010/MX 5010 Multifunction Interface System include: D/A converter, A/D converter, 32-channel digital I/O, 16-channel relay scanner, 10-channel low-level scanner (with a choice of signal conditioning modules), 16 k memory, and a user-configurable development card.

Each TM 5000 instrument (with the exception of the completely automatic AA 5001) is fully programmable—all front panel functions are programmable over the GPIB. Each instrument (again with the exception of the AA 5001) has a front-panel ID button which can be programmed to cause the instrument to generate an SRQ when pushed, to allow operator intervention in an on-going test. Conversely, the SRQ generation capability can be programmed off to prevent inadvertent operator intervention. In addition, the entire front panel of each instrument can be locked out to further prevent operator interference with a test or instrument set-up. When used with the execute-only version of the Tektronix 4041 System Controller, this means that you can place a completely operator-proof test system on the manufacturing floor; the operator can intervene only to the extent permitted by the test programmer.

In addition, Tektronix *Standard Codes and Formats* provides standardized data formats among all TM 5000 instruments, and among all other Tektronix GPIB instruments as well. Standardized instrument data formats open up the lines of bus communication and make your test and measurement system easy to set up and operate. Test and control functions are changed quickly and easily. Common error codes among instruments greatly simplify error-handling routines.

All of the TM 5000 instruments have internal diagnostics capability built right in. Each instrument performs an extensive diagnostic self-test on power-up or on command and, in case of a fault, displays and/or sends over the GPIB an error message indicating the nature of the fault. To further aid in troubleshooting and maintenance of the instruments, each has built-in signature analysis capability; each instruction manual gives a comprehensive list of signatures at nodes throughout the instrument.

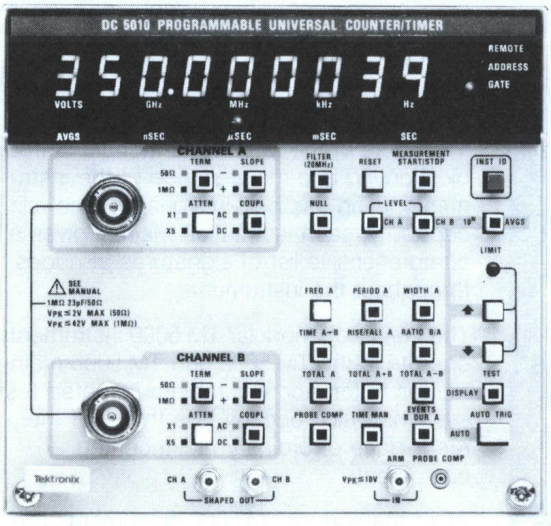
The compact, modular TM 5000 instruments operate in the TM 5003 and TM 5006 mainframes to form configurable automated test systems which occupy less than half the rack space of ordinary rackmounted equipment.

All of the current TM 5000 instruments are double-width, with the exception of the single-width DC 5009 and PS 5004. That is, each (except the DC 5009 and PS 5004) occupy two compartments of the three-compartment TM 5003 or the six-compartment TM 5006 mainframes.

Adherence to standard form and fit means that any TM 5000 product can be replaced in a system without the uncabling, unstacking, restacking, and recabling that is necessary with most instruments. Rebuilding the system for a different task takes seconds, not hours. And, if all instruments in your system need not be programmable, there are almost forty Tek TM 500 manual instruments compatible with TM 5000 mainframes.

All TM 5000 instruments are UL listed.

**DC 5010**




**Programmable Universal Counter/Timer**

# DC 5010

GPIB IEEE-488

The DC 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**350 MHz Both A and B Channels**

**3.125 ns Single-Shot Resolution**

**9-Digit Display**

**1 ps Resolution, with Averaging**

**Measurement Functions Include:**

**Reciprocal Frequency Measurement; Period; Width; Time A→B; Events B During A; Totalize A, A+B, A−B; Ratio; Rise/Fall; Time Manual; Arming; Null;**

**Auto or Selected Averaging to $10^9$ in All Modes**

**Duty-Cycle Independent Autotrigger**

**DVM Mode for Displaying Trigger Level Setting**

**Shaped A and B Channel Outputs**

**Hysteresis Compensation**

**Probe Compensation**

**See Digital Counter Selection Guide on page 358.**

Frequency measurements to 350 MHz (to 1.3 GHz with the Tektronix DP 501 Digital Prescaler), a wide range of time-interval measurement capabilities including risetimes and falltimes, hysteresis compensation, probe compensation, arming, and high resolution on low frequency signals (up to nine digits in one second or less), all combine to make the DC 5010 a true state-of-the-art universal counter/ timer. Selected averaging of up to $10^9$ events provides usable time-interval resolution to 1 ps on repetitive signals. The automatic averaging feature provides a compromise between measurement time and resolution, regardless of input signal frequency. The pseudo-random, phase modulated clock provides increased accuracy by eliminating the possibility of clock-synchronous errors in the time-interval averaging modes. Hysteresis compensation is automatic, further increasing the accuracy of time-interval measurements in the DC 5010. The Null feature permits the nulling of differences in cable lengths in time-interval measurements to provide direct readout of the measurement of interest.

Autotrigger, at the push of a button or upon command over the GPIB, senses the maximum and minimum of the applied signal and sets trigger level to a point midway between the two, regardless of duty cycle. The values of the maximum and the minimum are available over the bus where they can be used by the controller to compute the p-p amplitude of the signal, providing the function of a high-frequency p-p DVM. The value of the trigger level is also available over the bus, and may also be displayed in the nine-digit DC 5010 display. The outputs of both channels' signal shaping circuits are available at the front panel to aid in the proper setting of trigger levels on complex waveforms. The arming input allows measurement of selected events within complex waveforms. The unique Probe Compensation feature permits quick and accurate compensation of attenuator-type probes to provide accurate measurements on signals beyond the amplitude range of the counter itself.

The frequency measurement of the DC 5010 can be extended to 1.3 GHz with the use of the companion DP 501 Digital Prescaler. TM 5000 rear interfacing capability permits the operation of the DP 501 to be controlled over the GPIB through the DC 5010.

A field-installable modification kit is available to upgrade a manual DC 510 Universal Counter/Timer (page 359) to a GPIB programmable DC 5010 Universal Counter/ Timer.

## CHARACTERISTICS

**Display** — Nine-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate, and bus conditions. Overflow is indicated by a blinking display.

### CHANNEL A AND CHANNEL B INPUT

**Frequency Range**

50 Ω Termination: 0 MHz to 350 MHz dc coupled. 100 kHz to 350 MHz ac coupled.

1 MΩ Termination: 0 MHz to 300 MHz dc coupled. 16 Hz to 300 MHz ac coupled.

**Sensitivity**

50 Ω Termination Dc: 25 mV RMS sinewave to 350 MHz. 70 mV p-p pulse.

1 MΩ Termination Ac: 25 mV RMS to 200 MHz, 42 mV RMS to 300 MHz.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 MΩ paralleled by 23 pF ±2 pF or 50 Ω.

**Dynamic Range** — 4 V p-p x attenuation.

**Trigger Level Range** — +2 V to −2 V with 4 mV resolution (X1). +10 V to −10 V with 20 mV resolution (X5).

**Trigger Level Accuracy** — ±2% of reading for a dc input V, ±40 mV x attenuator.

**Autotrigger Frequency Range** — 10 Hz to 350 MHz.

**Independent Controls** — Slope +/−, Attenuation 1X/5X, Couple ac/dc, Impedance 1 MΩ/50 Ω.

**Maximum Input Voltage** — 1 MΩ input impedance.

1X: ±42 V (dc + peak ac) to 200 kHz; ±2 V (dc + peak ac) to 300 MHz.

5X: ±42 V (dc + peak ac) to 1 MHz; ±10 V (dc + peak ac) to 300 MHz.

In 50 Ω Input Impedance: Signals > ±2 V x attenuator will cause input protection circuitry to switch input to 1 MΩ.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms (≥100 mV typically to 350 MHz into 50 Ω load).

**Arming Input** — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

### FREQUENCY A

**Range** — 36 μHz to 350 MHz.

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

**Accuracy** — Resolution ± (Time Base Error x Frequency A)

### PERIOD A

**Range** — 3.125 ns to 7.6 hrs.

**Resolution** —

$$\pm\text{LSD} \pm \frac{1.4 \times \text{A Trigger Jitter Error}}{N}$$

**Accuracy** — Resolution ± (Time Base Error) x Period A.

### RATIO B/A

**Range** — $10^{-8}$ to $10^{9}$ (Frequency Range: 36 μHz to 350 MHz).

**Resolution** —

$$\pm\text{LSD} \pm \frac{1.4 \times \text{B Trigger Jitter Error} \times \text{Frequency B}}{N}$$

**Accuracy** — Same as Resolution.

### TIME A→B

**Range** — 2.0 ns to 7.6 hrs.

**Minimum Dead Time** — 12.5 ns (stop to start).

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm \text{ A Trigger Jitter Error} \pm \text{ B Trigger Jitter Error})$$

**Accuracy** — Resolution ± (Time Base Error x Time A→B) + (B Trigger Slew Error) − (A Trigger Slew Error) ± (Channel Delay Mismatch*[1]).

**Channel Delay Mismatch** — <2 ns between front panel inputs.

**Resolution** — Best time A→B Avg resolution = ±1 ps.

**Repetition Rate** — <70 MHz.

*[1] *Can be removed with "Null".*

### EVENTS B DURING A

**Range** — $10^{-8}$ to $10^{9}$.

**Maximum B Frequency** — 350 MHz.

**Maximum A Frequency** — 80 MHz.

**Minimum A Pulse Width** — 4.0 ns.

**Minimum Time Between A Pulses** — 8.5 ns.

**Minimum Dead Time Between Pulses** — ≤8.5 ns.

**Resolution** —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}}$$

±(Trigger Jitter Error CH A start edge ±Trigger Jitter Error CH A stop edge).

**Accuracy** — Resolution + Frequency B (Stop Slew Rate Error − Start Slew Rate Error) + Frequency B x (5 ±2 ns).

### WIDTH A

**Range** — 4 ns to 7.6 hrs.

**Minimum Dead Time Between Pulses** — 1.6 ns.

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trigger Jitter Error} \pm \text{Stop Trigger Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Width A) + (Stop Slew Rate Error − Start Slew Rate Error) ±2 ns.

**Repetition Rate** — 50 MHz.

### TIME MANUAL

**Range** — 0 to 3.125 x $10^{4}$ s (≈8 hrs).

**Resolution** — ±LSD (100 ms).

**Accuracy** — ±Resolution ±(Time Base Error x Time).

### TOTALIZE A

**Range** — 0 to $10^{9}$ counts.

**Repetition Rate** — 0 to 350 MHz.

### TOTALIZE A+B

**Range** — 0 to $10^{9}$ counts (A+B ≤$10^{9}$).

**Repetition Rate** — 0 to 350 MHz.

### TOTALIZE A−B

**Range** — −1 x $10^{8}$ to +1 x $10^{9}$ (either A >$10^{12}$ or B >$10^{12}$ will cause overflow).

**Repetition Rate** — 0 to 350 MHz.

### RISE/FALL A

**Range** — 4 ns to $10^{4}$ s (50 Ω) 5 ns to $10^{4}$ s (1 MΩ).

**Repetition Rate** — Minimum time between rising (falling) edges is 12.5 ns (80 MHz).

**Input Amplitude** — (1.4 V to 8 V) x Attenuation (50 Ω), (0.7 V to 4 V) x Attenuation (1 MΩ).

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}(\pm\text{Start Trigger Jitter Error} \pm \text{Stop Trigger Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Risetime/Falltime) ±2 ns ±4 mV x Slew Rate A Error (near 10%) ±4 mV Slew Rate A Error (near 90%).

### PROBE COMPENSATION

**Display** — 1 or 0 for each channel.

**Accuracy** — Probe Attenuation x Counter Attenuation x 0.300 (%).

### RESOLUTION AND ACCURACY DEFINITIONS

**Trigger Jitter Error (Seconds RMS)** —

$$\frac{\sqrt{(en1)^2 + (en2)^2}\ \text{(Volts RMS)}}{\text{Input Slew Rate at trigger point (V/s)}}$$

*Where: $e_{n1}$ = 140 μV RMS typical counter input noise for 1 MΩ filter on; 250 μV RMS typical for 1 MΩ, filter off and 340 μV RMS typical for 50 Ω.*
*$e_{n2}$ = RMS Noise Voltage of input signal at trigger point measured with 350 MHz bandwidth.*

**Slew Rate Error (Seconds)** —

$$\frac{\text{Trigger Level Error (V)}^{*1}}{\text{Input Slew Rate at Trigger Point (V/s)}}$$

*[1] Trigger level error =*

| | | |
|---|---|---|
| All functions except Width and Events B During A | Positive Slope | Trigger accuracy times ATTN factor |
| | Negative Slope | (Trigger accuracy ±10 mV) times ATTN factor |
| Width A ⎍ | Start Edge | Trigger accuracy times ATTN factor |
| | stop edge | (trigger accuracy + hyst) times ATTN factor |
| ⎎ | Start Edge | (Trigger accuracy + hyst) times ATTN factor |
| | Stop Edge | Trigger accuracy times ATTN factor |
| Events B During A | Same as Width, except each number is multiplied by (Frequency B) | |

*Note: Input hysteresis is typically 50 mV p-p x attenuation.*
*N=Number of events averaged.*

The minimum number of averages is selected by the Averages button and the ↑ ↓ buttons in decade steps from 1 to $10^{9}$. At Channel A repetition rates above ≈250 Hz, the actual number of averages will be:

N = [Frequency A (Hz) x 4 ms] + Averages.
N = Averages setting (below 250 Hz).

This calculation typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. It does mean, however, that Arming must be used where only N = 1 is desired for signals ≥250 Hz.

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms (or the time for one event, whichever is greater).

N = Frequency A (Hz) x 0.3 s
(N always ≥1).

**Time Base Error** — The sum of all errors specified for the time based used.

### STANDARD TIME BASE

**Crystal Frequency** — 10 MHz.

**Temperature Stability** — ±5 x $10^{-6}$, 0°C to +50°C.

**Aging Rate** — ≤1 x $10^{-6}$/year.

**Setability** — Adjustable to within ±5 x $10^{-8}$.

### HIGH STABILITY TIME BASE (OPTION 01)

**Crystal Frequency** — 10 MHz.

**Temperature Stability** — ±2 x $10^{-7}$, 0°C to +50°C.

**Warm-Up Time** — ±2 x $10^{-7}$ of final frequency in <10 minutes when cold started at 25°C.

**Aging Rate** — ≤1 x $10^{-8}$/day at time of shipment, 4 x $10^{-8}$/week after 30 days of continuous operation, 4 x $10^{-6}$/year after 60 days of continuous operation.

**Setability** — Adjustable to within ±2 x $10^{-8}$.

### REAR INTERFACE

**Inputs** — Arming; reset; external time base (1 MHz, 5 MHz, or 10 MHz), prescale.

**Outputs** — 1 MHz clock.

### OTHER CHARACTERISTICS

**Power Consumption** — 14.5 W (≈19.. W or Option 01).

**GPIB Data Output Rate** — ≈10 readings/s maximum.

**TM 5000 Power Module Compatibility** — The DC 5010 is not compatible with TM 500 Series mainframes.

## ORDERING INFORMATION

**DC 5010** Programmable Universal Counter/Timer **$4,485**

**Includes:** Shaped output cable (012-0532-00); instruction manual (070-3897-02); instrument interfacing guide (070-4611-00); reference guide (070-3553-00).

**OPTIONS**

**Option 01** — High Stability Time Base. **+$325**

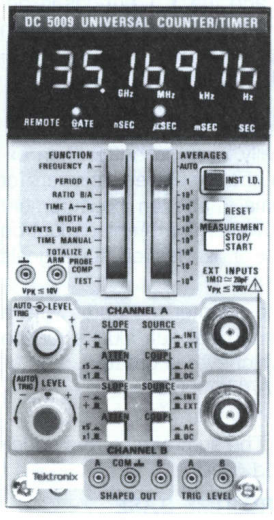
**Field Option 01 Kit** — For DC 510/5010. Order 040-0966-00 **$250**

**Utility Software**
For TM 5000/4041. Order 062-6958-01 **$150**
See page 297 for description and ordering information.

**RECOMMENDED PROBE**

**P6125** — 5X Passive Probe. Order 010-6125-01 **$70**

DC 5009




**Programmable Universal Counter Timer**

# DC 5009

GPIB IEEE-488 The DC 5009 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**135 MHz Both A and B Channels**

**10 ns Single-Shot Resolution**

**8-Digit Display**

**5 ps Resolution, with Averaging**

**Measurement Functions Include:**
- **Reciprocal Frequency Measurement**
- **Period**
- **Width**
- **Time A→B**
- **Events B During A**
- **Totalize A→B**
- **Ratio**
- **Time Manual**
- **Arming**

**Auto or Selected Averaging to $10^8$ in All Modes**

**Duty-Cycle Independent Autotrigger**

**Shaped A and B Channel Outputs**

**Probe Compensation**

The DC 5009 single-width Universal Counter/Timer provides all of the measurement functions of the higher performance DC 5010 except risetime/falltime, null, and totalize A ± B. This makes it the lowest cost fully programmable universal counter/timer available at the present time.

The powerful reciprocal frequency measurement technique allows up to eight digits of resolution of low frequency signals in one second or less of measurement time. The DC 5009 has the same automatic averaging feature as the DC 5010; selected averaging of up to $10^8$ events provides usable time-interval resolution of 5 ps.

Like the DC 5010, the frequency measurement capability of the DC 5009 can be extended to 1.3 GHz with the use of the DP 501 Digital Prescaler. The TM 5000 rear interfacing capability allows the operation of the DP 501 to be controlled over the GPIB through the DC 5009.

A field-installable modification kit is available to upgrade a manual DC 509 Universal Counter/Timer (page 359) to a GPIB programmable DC 5009 Universal Counter/Timer.

**See Digital Counter Selection Guide on page 358.**

## CHARACTERISTICS

**Display** — Eight-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate. Overflow is indicated by a blinking display.

### CHANNEL A AND B INPUT

**Frequency Range** — 0 MHz to 135 MHz dc coupled, 10 Hz to 135 MHz ac coupled.

**Sensitivity** — 20 mV RMS sinewave to 100 MHz, 40 mV RMS sinewave to 135 MHz, 115 mV p-p at minimum, pulse width of 3 ns.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 MΩ paralleled by ≤30 pF.

**Trigger Level Range** — +3.200 V to −3.175 V with 25 mV resolution (X1). +16 V to −15.875 V with 125 mV resolution (X5).

**Trigger Level Accuracy** — ±45 mV ±40 µV/°C referenced to 25°C.

**Dynamic Range** — V p-p ≤3 x Attenuation, tr ≤5 ns. V peak ≤3.2 x Attenuation.

**Autotrigger Frequency Range** — 20 Hz to 100 MHz ($V_{in}$ ≥125 mV p-p).

**Independent Controls** — Slope +/−, attenuation 1X/5X, Couple ac/dc, Source Internal/External.

**Maximum Input Voltage**
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p at 135 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 25 V p-p at 135 MHz.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms. Amplitude 0 V to ≥+0.3 V from 50 Ω.

**Trigger Level Out** — A dc level corresponding to the actual trigger level. Accuracy within ±30 mV of internal trigger level.

**Arming Input** — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

### FREQUENCY A

**Range** — 100 µHz to 135 MHz.

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

**Accuracy** — Resolution ±(Time Base Error x Frequency A)

### PERIOD A

**Range** — 7.40 ns to 3.05 hrs.

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N}$$

**Accuracy** — Resolution ±(Time Base Error x Period A).

### RATIO B/A

**Range** — $10^{-7}$ to $10^8$ (Frequency Range: CH A to 135 MHz; CH B to 125 MHz.)

**Resolution** —

$$\pm\text{LSD} \pm 1.4 \times \frac{\text{B Trigger Jitter Error} \times \text{Frequency B}}{N}$$

**Accuracy** — Same as Resolution.

### TIME A→B

**Range** — 15 ns to 3.05 hrs.

**Minimum Dead Time** — 15 ns (stop to start).

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}} \times (\pm\text{A Trigger Jitter Error} \pm \text{B Trigger Jitter Error})$$

**Accuracy** — Resolution ±(Time Base Error x Time A→B) + (B Trigger Slew Error − A Trigger Slew Error) ± (Channel Delay Mismatch).

**Channel Delay Mismatch** — <2 ns between front panel inputs and <3 ns between rear interface inputs.

**Repetition Rate** — <35 MHz.

### EVENTS B DURING A

**Range** — $10^{-7}$ to $10^8$.

**Maximum B Frequency** — 125 MHz.

**Minimum A Pulse Width** — 15 ns.

**Minimum Time Between A Pulses** — 15 ns.

**Minimum Time Between "A" Start Edge and First "B" Event** — 15 ns.

**Resolution** —

$$\pm\text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}}$$

±Trigger Jitter Error CH A start edge
±Trigger Jitter Error CH A stop edge.)

**Accuracy** — Resolution + Frequency B (Stop Slew Rate Error — Start Slew Rate Error).

### WIDTH A

**Range** — 15 ns to 3.05 hrs.

**Minimum Dead Time Between Pulses** — 15 ns.

**Resolution** —

$$\pm\text{LSD} + \frac{1}{\sqrt{N}}$$

(±Start Trigger Jitter Error
±Stop Trigger Jitter Error)

**Accuracy** — Resolution ±(Time Base Error x Width A) + (Stop Slew Rate Error — Start Slew Rate Error) ±5 ns.

### TIME MANUAL

**Range** — 0 to 3.05 hrs. May be extended with GPIB.

**Resolution** — ±LSD (100 ms).

**Accuracy** — ±Resolution ±(Time Base Error x Time).

### TOTALIZE A

**Range** — 0 to 1.09 x $10^{12}$ counts. May be extended with GPIB.

**Repetition Rate** — 0 MHz to 135 MHz.

### PROBE COMPENSATION

**Display** — 1 or 0 for each channel.

**Accuracy** —

$$\frac{\text{Probe Attenuation} \times 50\text{ mV} \times 100\ (\%)}{V_{in} \text{ at Probe}}$$

(2.5% nominal for X5 probe with 10 V p-p at the probe).

### RESOLUTION AND ACCURACY DEFINITIONS

**Trigger Jitter Error (Seconds RMS) —**

$$\frac{\sqrt{(en1)^2 + (en2)^2}\ \text{(Volts RMS)}}{\text{Input Slew Rate at trigger point (V/s)}}$$

*Where: $en1$ = 120 µV RMS typical counter input noise*
*$en2$ = RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.*

**Slew Rate Error (Seconds) —**

$$\frac{\text{Input Hysteresis/2}}{\text{Input Slew Rate at trigger point (V/s)}}$$

*Note: Input hystersis is typically 20 mV p-p.*
*N = Number of Events Averaged*

The minimum number of averages is selected by the averages control in decade steps from 1 to $10^8$. At Channel A repetition rates above ≈250 Hz, the number of events averaged will be:

N = [Frequency A (Hz) x 4 ms] +Averages.

N = Averages setting (below 250 Hz).

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms.

N = Frequency A (Hz) x 0.3 s. (N is always ⩾1).

**Time Base Error —** The sum of all errors specified for the time base used.

### STANDARD TIME BASE

**Crystal Frequency —** 10 MHz.

**Temperature Stability —** ±5 x $10^{-6}$, 0°C to +50°C.

**Aging Rate** = 1 x $10^{-6}$ per year.

**Setability —** Adjustable to within ±1 x $10^{-7}$ or better.

### HIGH STABILITY TIME BASE (OPTION 01)

**Crystal Frequency —** 10 MHz.

**Temperature Stability —** ±2 x $10^{-7}$ after warm-up, 0°C to +50°C.

**Warm-up Time —** Within 2 x $10^{-7}$ of final frequency in <10 minutes when cold-started at 25°C.

**Aging Rate —** 1 x $10^{-8}$/day at time of shipment, 4 x $10^{-8}$/week after 30 days of continuous operation, 1 x $10^{-6}$/year after 60 days of continuous operation.

**Setability —** Adjustable to within 2 x $10^{-8}$.

### REAR INTERFACE

**Inputs —** Channel A and Channel B input to 50 MHz (50 Ω impedance, maximum input 3.6 V peak); arming; reset; external time base (1 MHz, 5 MHz, or 10 MHz), prescale.

**Outputs —** Channel A and Channel B shaped outputs; Channel A and Channel B trigger level outputs; 10 MHz clock; gate out.

### OTHER CHARACTERISTICS

**Power Consumption —** ≈12 W (≈15 W with Option 01).

**GPIB Data Output Rate —** ≈10 readings/s maximum.

**TM 5000 Power Module Compatibility —** The DC 5009 is not compatible with TM 500 Series mainframes.

## ORDERING INFORMATION

**DC 5009** Programmable Universal Counter Timer **$2,650**

**Includes:** Tip jack to BNC adaptor cable (175-3765-01); instruction manual (070-3888-00); instrument interfacing guide (070-4612-00); reference guide (070-3560-01).

### OPTIONS

**Option 01 —** High Stability Time Base. **+$325**

**Field Option 01 Kit —** For DC 509. Order 040-0966-00 **$250**

**Utility Software**
For TM 5000/4041. Order 062-6958-01 **$150**
See page 297 for description and ordering information.

### RECOMMENDED PROBE

**P6125 —** 5X Passive Probe. Order 010-6125-01 **$70**

# DP 501

**Extends Frequency Measurement Capability to 1.3 GHz**

**Compatible with Most TM 5000 and TM 500 Counters**

**AGC**

**Low Level Indicator**

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 509/5009, DC 510/5010, and DC 503A Universal Counter/Timers while still allowing full use of all counter/timer functions. There is no need to change input connections as with counters which use the conventional C-Channel input.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal frequency by 16 and the associated counter's display to be multiplied by 16 (so that the counter will display the correct frequency). In the Direct mode the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching of the input signal when changing from high frequency measurements to low frequency or time-interval measurements.

The prescaling function can be activated in either of two ways: manually, with a front-panel pushbutton; or, by the "Prescale On" command to the counter when using a GPIB programmable DC 5009 or DC 5010.

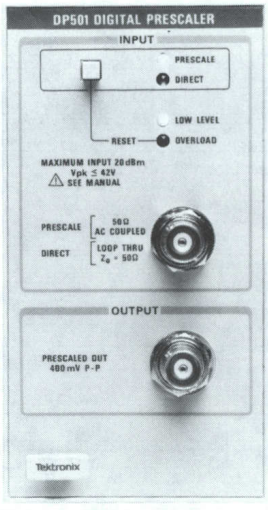
Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting.

An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and the DC 509/DC 5009 or DC 510/DC 5010 Universal Counter/Timers can be used with the Tektronix 7L14 Spectrum Analyzer (see page 166) and TR 502 Tracking Generator (see page 172) to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

The DP 501 operates in a single compartment of either a TM 500 or TM 5000 mainframe.

**DP 501**




**Digital Prescaler**

## CHARACTERISTICS

**Prescale Mode**

**Input —** Frequency range is ⩽100 MHz to ⩾1.3 GHz.

**Sensitivity —** 100 MHz to 1 GHz is ⩽20 mV RMS (−21 dBm). 1 GHz to 1.3 GHz is ⩽30 mV RMS (−17 dBm).

**Impedance —** 50 Ω ac coupled; vswr ⩽2.2:1.

**Output —** Amplitude into 50 Ω is ⩾200 mV. Unterminated is 2X terminated value.

**Direct Mode**

**Input —** Connected directly to output.

**Frequency Range —** 0 MHz to >350 MHz.

**Impedance —** Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output).

**Output —** Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

**Overload Protection —** Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

**Damage Level —** Prescale: Input may be damaged if signal level exceeds +25 dBm.
Direct: 42 V peak maximum. Maximum current is 250 mA.

**Input Attenuation —** Automatic: Up to 40 dB range.

**Low Level Indicator —** Lights when input signal is below that required for error-free counting.

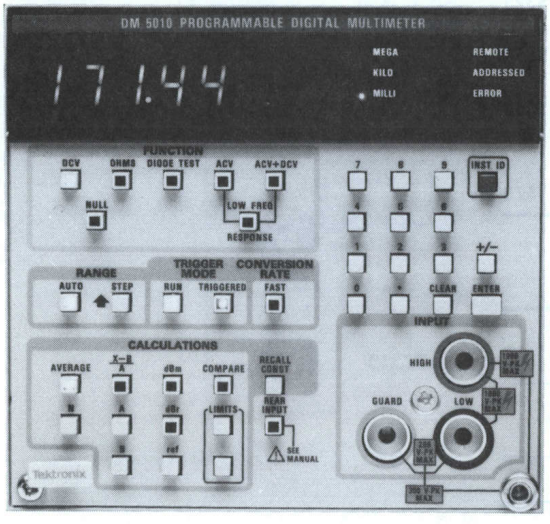
**Tracking Generator Compatibility —** Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

## ORDERING INFORMATION

**DP 501** Digital Prescaler **$575**

**Includes:** Instruction manual (070-4332-00).

**DM 5010**




**Programmable Digital Multimeter**

# DM 5010

GPIB IEEE-488 The DM 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**4 1/2 Digit, Autoranging**

**Dc Volts, Ohms, True RMS (ac or ac+dc)**

**Diode Test**

**Comprehensive Math Functions: dB Calculations; Averaging; Offset; Scaling; Hi/Lo/Pass**

The DM 5010 Programmable Digital Multimeter measures dc voltage, resistance, true RMS ac voltage, and true RMS ac+dc voltage. The internal math capability of the DM 5010 provides most of the calculations normally required for reducing raw measurements to decision-supporting information without controller assistance. These calculations include averaging (up to 19,999 measurements), offset and scaling, conversion to dBm or reference dB, and Hi/Lo/Pass comparisons. User-selectable constants required for calculations may be supplied either through the front-panel keypad or via the GPIB.

The internal math capability of the DM 5010 permits such specialized measurements as: ac or dc current measurements, through the use of an external shunt resistor and a scaling factor equal to the ohmic value of the resistor; comparison against a percent tolerance (as opposed to an absolute value tolerance) through the combined use of the scaling and Hi/Lo/Pass functions.

The low voltage (0.2 volt) ohms function allows in-circuit resistance measurements without turning on parallel diode and transistor junctions. A Diode Test function is provided for forward and reverse testing of diode and transistor junctions.

The versatile TM 5000 rear interfacing capability allows signals to be applied to the DM 5010 via the rear interface connector as well as via the front panel input jacks. This front-rear selection capability allows the rapid comparison of two signals or voltage levels, such as the input and the output of a device, without the need for external switching of the signal. Selection of front or rear signal input may be made under bus control or by front-panel pushbutton.

The DM 5010 is fully guarded, with the Guard connector automatically connected to the Low input when there is no Guard signal lead inserted.

The Null function eliminates much of the requirement for four-wire ohms connections by allowing the operator, or the system, to null out lead resistance in resistance measurements. The Null function also allows the difference between two measurements to be displayed, either directly or as a dB difference.

A special Low Frequency Response function permits stable readouts of low frequency ac voltages.

Range selection is either automatic or manually incremented. Measurements and calculations may be triggered by internal circuitry, a front-panel pushbutton, a rear interface signal, or a GPIB command.

Calibration of the DM 5010 is greatly simplified through the use of internal microprocessor-computed nonvolatile calibration constants.

## CHARACTERISTICS

### DC VOLTS

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 1000 V.

**Accuracy**[*1]

| +18°C to +28°C | | |
|---|---|---|
| **Voltage Ranges** | **Normal Conversion Rate** | **Fast Conversion Rate** |
| 200 mV | ±[0.015% of reading +0.01% of full scale (2 counts)] | ±[0.05% of reading +0.05% of full scale (1 count)] |
| 2 V through 200 V | ±[0.015% of reading +0.005% of full scale (1 count)] | ±[0.05% of reading +0.05% of full scale (1 count)] |
| 1000 V | ±[0.020% of reading +0.010% of full scale (2 counts)] | ±[0.05% of reading +0.1% of full scale (2 counts)] |
| **0°C to 18°C, +28°C to +50°C** | | |
| 200 mV | ±[0.06% of reading +0.035% of full scale (7 counts)] | ±[0.1% of reading +0.1% of full scale (2 counts)] |
| 2 V through 200 V | ±[0.06% of reading +0.03% of full scale (6 counts)] | ±[0.1% of reading +0.1% of full scale (2 counts)] |
| 1000 V | ±[0.065% of reading +0.035% of full scale (7 counts)] | ±[0.1% of reading +0.15% of full scale (3 counts)] |

*[1] *Valid for six months or 1000 operating hours, whichever occurs first.*

**Common-Mode Rejection Ratio (With 1 kΩ Imbalance)** — Unguarded: ⩾130 dB at dc. ⩾80 dB at 50 Hz to 60 Hz.
Guarded: ⩾140 dB at dc. ⩾100 dB at 50 Hz to 60 Hz.

**Normal-Mode Rejection Ratio** — ⩾40 dB at 50 Hz or 60 Hz ±0.2 Hz.

**Maximum Resolution** — 10 μV.

**Step Response Time (To Rated Accuracy)**

**Run Mode** — Normal conversion rate is ⩽0.53 s. Fast conversion rate is ⩽0.08 s.

**Triggered Mode** — Normal conversion rate is ⩽0.33 s. Fast conversion rate is ⩽0.06 s.

**Input Resistance** — 200 mV to 20 V Range: $>10^9$ Ω.
200 V to 1000 V Range: 10 MΩ ±0.25%.

**Maximum Input Voltage** — 1000 V peak.

### TRUE RMS AC VOLTS (ACV AND AC+DC)

**Input Signal** — Must be between 5% and 100% of full scale.

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 700 V.

**Accuracy**[*1]

**Ac Volts and Ac Volts + Dc Volts**

| +18°C to +28°C | Normal and Fast Conversion | | |
|---|---|---|---|
| **Voltage Ranges** | **20 Hz to 100 Hz** | **100 Hz to 20 kHz** | **20 kHz to 100 kHz** |
| 200 mV through 200 V | ±(0.8% of rdg +0.2% of full scale) | ±(0.2% of rdg +0.2% of full scale) | ±(1.0% of rdg +0.5% of full scale) |
| 700 V (15 kHz maximum) | ±(0.8% of rdg +0.6% of full scale) | ±(0.2% of rdg +0.6% of full scale) | |
| **0°C to +18°C, +28°C to +50°C** | | | |
| 200 mV through 200 V | ±(1.25% of rdg +0.35% of full scale) | ±(0.65% of rdg +0.3% of full scale) | ±(1.45% of rdg +0.65% of full scale) |
| 700 V (15 kHz maximum) | ±(1.25% of rdg +0.95% of full scale) | ±(0.65% of rdg +0.95% of full scale) | |

**Ac Volts + Dc Volts Only**

| +18°C to +28°C | |
|---|---|
| **Voltage Ranges** | **Normal and Fast Conversion Rates 10 Hz to 20 Hz** |
| 200 mV through 200 V | ±(0.8% of rdg +0.3% of full scale) |
| 700 V | ±(0.8% of rdg +0.9% of full scale) |
| **0°C to +18°C, +28°C to +50°C** | |
| 200 mV through 200 V | ±(1.25% of rdg + 0.45% of full scale) |
| 700 V | ±(1.25% of rdg + 1.25% of full scale) |

*[1] *Valid for six months or 1000 operating hours, whichever occurs first.*

**Common-Mode Rejection Ratio** — Unguarded: Typically ⩾80 dB from dc to 60 Hz. Guarded: Typically ⩾100 dB from dc to 60 Hz.

**Maximum Resolution** — 10 μV.

**Response Time** — <1.2 s (except for Low Frequency Response mode).

**Input Impedance** — 2 MΩ ±0.1% paralleled by <150 pF.

**Maximum Input Voltage** — 1000 V peak ac, 500 V dc.

**Crest Factor** — Four (subject to maximum peak input voltage).

**See DMM Selection Guide on page 363.**

### DIODE TEST

**Operation —** A 1 mA current is generated and the resultant voltage is measured on the 2 V dc range. This produces a voltage sufficient to turn on diode and transistor junctions.

### RESISTANCE

**Ranges —** 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

**Accuracy*1**

+18°C to +28°C

| Resistance Range | Normal Conversion Rate | Fast Conversion Rate |
|---|---|---|
| 200 Ω | ±[0.015% of reading +0.015% of full scale (3 counts)] (using null)*2 | ±[0.05% of reading +0.05% of full scale (1 count)] (using null)*2 |
| 2 kΩ to 200 kΩ | ±[0.015% of reading +0.01% of full scale (2 counts)] (using null on 2 kΩ only)*2 | ±[0.05% of reading +0.05% of full scale (1 count)] |
| 2 MΩ | ±[0.10% of reading +0.01% of full scale (2 counts)] | ±[0.10% of reading +0.05% of full scale (1 count)] |
| 20 MΩ | ±[0.15% of reading +0.005% of full scale (1 count)] | ±[1.0% of reading +0.05% of full scale (1 count)] |

**Accuracy*1**

0°C to +18°C, +28°C to +50°C

| Resistance Range | Normal Conversion Rate | Fast Conversion Rate |
|---|---|---|
| 200 Ω | ±[0.06% of reading +0.06% of full scale (12 counts)] (using null)*2 | ±[0.1% of reading +0.1% of full scale (2 counts)] (using null)*2 |
| 2 kΩ to 200 kΩ | ±[0.06% of reading +0.035% of full scale (7 counts)] (using null on 2 kΩ only)*2 | ±[0.1% of reading +0.1% of full scale (2 counts)] |
| 2 MΩ | ±[0.54% of reading +0.035 of full scale (7 counts)] | ±[0.55% of reading +0.1% of full scale (2 counts)] |
| 20 MΩ | ±[0.9% of reading +0.01% of full scale (2 counts)] | ±[1.6% of reading +0.05% of full scale (1 count)] |

*1 *Valid for six months or 1000 operating hours, whichever occurs first.*

*2 *When the null function is not used add ±0.2 Ω to all readings.*

**Maximum Resolution —** 10 mΩ.

**Step Response Time (To Rated Accuracy)**

**Run Mode —** Normal conversion rate is ⩽1.24 s. Fast conversion rate is ⩽0.33 s.

**Triggered Mode —** Normal conversion rate is ⩽0.73 s. Fast conversion rate is ⩽0.19 s.

**Maximum Input Volts —** 400 V peak.

**Maximum Open Circuit Voltage Developed —** <5 V.

### OTHER CHARACTERISTICS

**Overrange Indication —** For Ohms and Diode Test, "OC" is displayed; for ACV, DCV, ACV+DCV, the display blinks.

**Measurement Rate —** ACV, DCV, ACV+DCV, Diode Test: 3/s at 4.5 digits; 26/s at 3.5 digits. Ohms: 1.6/s at 4.5 digits; 7.1/s at 3.5 digits.

**Power Consumption —** ≈20 VA.

**IEEE Standard 488-1978 Interface Function Subsets Implemented —** SH1, AH1, T5, L4, SR1, RL1, PPØ, DC1, DT1, CØ

## ORDERING INFORMATION

**DM 5010** Programmable Digital Multimeter **$2,260**

**Includes:** One set test leads (003-0120-00); instruction manual (070-2994-01), instrument interfacing guide (070-4603-00); reference guide (070-3542-00).

**Utility Software**
For TM 5000/4041. Order 062-6958-01 **$150**
See page 297 for description and ordering information.

### OPTIONAL ACCESSORIES

**Test Lead —** Black, 4 ft.
Order 012-0425-00 **$12**

**Test Lead —** Red, 4 ft.
Order 012-0426-00 **$22**

**Test Lead —** Black, 4 ft.
Order 012-0426-01 **$22**

**Test Lead Set —** Includes 012-0425-00, 012-0426-00, and 013-0107-05.
Order 012-0427-00 **$29**

**High Voltage Probe —** To 40 kV (complete information page 366).
Order 010-0277-00 **$165**

**P6420 RF Probe —** 2 m cable included (complete information page 441).
Order 010-6420-03 **$145**

**Female BNC to Dual Banana Adaptor —** Order 103-0090-00 **$7.50**

# FG 5010

GPIB IEEE-488 The FG 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**0.002 Hz to 20 MHz**

**Up to 20 V p-p from 50 Ohms**

**Sine, Square, Triangle, Pulse, and Ramp Waveforms**

**10 ns Rise/Fall**

**10% to 90% Variable Symmetry in 1% Steps**

**Trigger, Gate, Counted Burst**

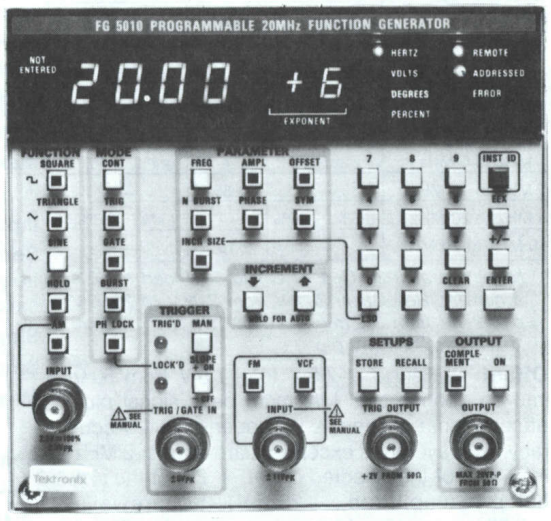
**Phase Lock, with Autoscan**

**AM, FM, VCF**

**Waveform Complement**

The FG 5010 Programmable 20 MHz Function Generator is a highly versatile GPIB programmable instrument and also extremely easy to operate in the manual mode as well. All functions are addressable via the lighted front-panel pushbuttons with nomenclature and functionality clearly designated. The ability to store ten complete front panel setups and recall them with only two keystrokes or by a single command over the GPIB reduces GPIB programming time and enhances stand-alone bench applications.

FG 5010




**Programmable 20 MHz Function Generator**

The FG 5010 provides the conventional sine, square, triangle, pulse, and ramp waveforms. Variable symmetry, which is usable throughout the entire frequency range, extends pulse and ramp capabilities beyond those of conventional generators. The FG 5010 also provides trigger, gate, counted burst, phase lock, AM, FM, and VCF modes. Variable phase enhances the trigger, gate, burst, and phase lock modes. The wide frequency range assures its usefulness in radio and other communication-oriented applications as well as in low frequency applications, such as biological, geophysical, and mechanical simulations.

The FG 5010 maintains frequency accuracy within 0.1% over its full 0.002 Hz to 20 MHz frequency range. Automatic phase lock to an external signal is possible from 20 Hz to 20 MHz. Waveform complement and +/− trigger slope allow interfacing to circuits with the proper waveform phase, especially important in pulse and digital applications. Waveform hold can freeze the output voltage of any 200 Hz or less waveform at its instantaneous value. With the output amplitude set to zero volts, the dc offset can be programmed to provide a dc voltage source of 0 volts to ±7.5 volts in 10 mV steps.

### CHARACTERISTICS

**Waveform —** Sine, Square and Triangle with variable Symmetry providing Pulses and Ramps.

**Symmetry —** 10% to 90%, 1% steps, ±2% accuracy. Range above 4 MHz is limited by 25 ns minimum triangle transition time (decreases to 50% at 20 MHz).

**Frequency —** Range: 0.002 Hz to 20 MHz. Accuracy: Continuous mode, ±0.1%. Trigger, Gate, Burst Modes: Frequency ⩽200 Hz, ±0.1%; frequency >200 Hz, ±5.0%. Resolution: Continuous mode, 4 digits, Trigger, Gate, Burst modes. Frequency ⩽200 Hz, 4 digits. Frequency >200 Hz, 3 digits.

**Amplitude —** Range: 20 mV to 20 V p-p from 50 Ω into open circuit.

**Accuracies*[1]**

| Frequency | Sine | Square | Triangle |
|---|---|---|---|
| 0.002 Hz to 1 kHz | ±3% | ±2% | ±2% |
| 1 kHz to 100 kHz | — | — | ±3.5% |
| 1 kHz to 1 MHz | ±3.5% | ±3.5% | — |
| 100 kHz to 1 MHz | — | — | ±4% |
| 1 MHz to 5 MHz | ±5% | — | +4%, −5% |
| 1 MHz to 10 MHz | — | ±5% | — |
| 5 MHz to 20 MHz | ±5%, −10% | — | +4%, −20% |
| 10 MHz to 20 MHz | — | ±10% | — |

*[1] *Measured at +25°C ±10°C into 50 Ω load at 50% symmetry. Resolution: 20 mV from 2.02 V to 20.00 V p-p, 2 mV from 202 mV to 2.000 V p-p, 0.2 mV from 20.0 mV to 200.0 mV p-p.*

**Offset** — Range: −7.5 V to +7.5 V from 50 Ω into an open circuit. Maximum peak signal plus offset cannot exceed ±15 V open circuit. Accuracy: All waveforms except squarewave >2 MHz ≤ ±(1% of the selected offset, + 2% of the signal p-p amplitude, +20 mV). Squarewave >2 MHz <±(1% of the selected value +5% of the signal p-p amplitude +20 mV). Resolution: 10 mV open circuit, 5 mV into 50 Ω load. 0 V is also provided.

**Output Impedance** — 50 Ω.

**Sinewave Distortion** — 20 Hz to 19.99 kHz, ≤0.5%; 20.0 kHz to 99.99 kHz, ≤1.0%; 100 kHz to 20.0 MHz, harmonics >30 dB down from 100 kHz to 20 MHz. Valid from +15°C to +35°C into 50 Ω load with 0 V offset, continuous mode, 50% symmetry, and AM, FM, VCF, and Complement off.

**Squarewave Response** — Risetime and falltime are ≤10 ns. Aberrations are ≤5% p-p +20 mV.

**Typical Triangle Linearity (10% to 90%)** — 0.002 Hz to 200 Hz, ≤1%; 200 Hz to 100 kHz, ≤1%; 100 kHz to 2 MHz, ≤2%; 2 MHz to 20 MHz, ≤10%.

**Trigger Output** — 0 V ±100 mV to ≥+2 V from 50 Ω source impedance into an open circuit.

### TRIG, GATE, BURST, AND PH LOCK INPUT

**Input Impedance** — 1 MΩ or 50 Ω, internally selectable.

**Trigger Threshold** — 0 V or + 0.5 V, internally selectable.

**Amplitude Sensitivity** — ≤250 mV p-p.

**Slope** — Plus or minus, plus only in Ph Lock.

**Minimum Pulse Width** — 25 ns.

**Maximum Frequency** — 20 MHz.

**Maximum Input Amplitude** — ±5 V peak into 50 Ω, ±20 V peak into 1 MΩ.

**Burst Range** — 1 cycle to 9999 cycles.

**Phase Lock Range** — Automatic capture from 20 Hz to 20 MHz.

**Phase Lock Time** — Typically 8 ms to 88 s, depending on final frequency and start frequency.

### AM INPUT

**Input Impedance** — 10 kΩ (±5% when AM is selected).

**Sensitivity** — 5 V p-p produces ≥100% modulation.

**Distortion** — <2% at 70% modulation and ≤2 MHz; <4% at 70% modulation and >20 MHz.

**Bandwidth** — Dc to ≥100 kHz.

**Maximum Input Amplitude** — ±20 V pk.

### FM INPUT

**Input Impedance** — 10 kΩ.

**Sensitivity** — 0 V to ±1 V modulates to ≥±1% deviation from center frequency.

**Distortion** — ≤2%.

**Bandwidth** — Dc to ≥100 kHz.

**Maximum Input Amplitude** — ±20 V peak.

### VCF INPUT

**Input Impedance** — 10 kΩ ±5%.

**Sensitivity** — 0 V to 10.0 V produces a ≥1000:1 frequency change, positive going voltage increases frequency.

**Slew Rate** — ≥0.063 V/μs.

**Bandwidth** — Dc to ≥100 kHz.

**Maximum Input Amplitude** — ±20 V peak.

### OUTPUT HOLD MODE

**Range** — 0.002 Hz to 200 Hz. (Output holds at instantaneous value).

### PHASE (TRIG, GATE, AND BURST MODES)

**Range** — ≤90° to 1 MHz, decreasing to ≤80° at 20 MHz.

**Accuracy** —

$$\pm 3° \text{ to } 500 \text{ kHz}; \pm\left[7° + \left(\frac{\text{freq}}{20 \text{ MHz}} \times 28\% \times |\Phi|\right)°\right]$$

for freq >500 kHz. At 25 ±10°C VCF off, output in Normal and symmetry at 50%.

**Resolution** — 1°.

### PHASE (PH LOCK MODE)

Specifications apply for ambient temperature of 25°C ±10°C.

**Range** — ≤90°, 20 Hz to ≤10 MHz; ≤45° to ≥10 MHz (Complementing the output extends effective 0 range to ±180°).

**Accuracy** — ±(2° +5% of selected value).

**Resolution** — 1°.

### OTHER CHARACTERISTICS

**Power Consumption** — 60 W.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PPØ, DC1, DT1, CØ.

## ORDERING INFORMATION

**FG 5010** 20 MHz Function Generator **$3,995**

**Includes:** Instruction manual (070-3467-01), instrument interfacing guide (070-4613-00), reference guide (070-3561-00),

**Utility Software**

For TM 5000/4041 Order 062-6958-01 **$150**

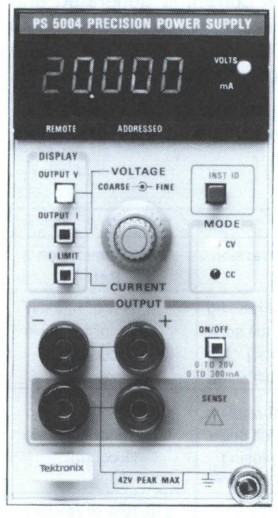
See page 297 for description and ordering information.

### OPTIONAL ACCESSORIES

**Rear Interface Signal Cable Kit** — Order 020-0701-00 **$35**

**Service Kit** — Order 067-1041-00 **$280**

**PS 5004**




**Programmable Precision Power Supply**

# PS 5004

GPIB IEEE-488 The PS 5004 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**0 V to 20 V Floating Output**

**0.01% Accuracy**

**500 μV/0.1 mA Resolution**

**Constant Voltage or Constant Current with Autocrossover**

**Voltage and/or Current Monitoring Display**

**Remote Sensing**

The single-width PS 5004 Precision Power Supply provides the high-resolution voltages and currents necessary in the characterization of transistor, IC, and other semiconductor and hybrid circuits and in the operation of high-performance strain gages and other transducer systems. Its entire 0 V to 20 V output is covered with a coarse and fine adjustment to provide rapid setability and ±500 μV resolution without the necessity of changing ranges. Setability resolution over the GPIB is also ±500 μV. The supply output is available at the rear interface as well as from the front panel terminals. Overall accuracy is ±0.01% ±2 mV.

The PS 5004 operates in either a constant voltage or constant current mode with autocrossover between the two. Front panel annunciators indicate the mode at all times. The operating mode is also reported over the bus and the PS 5004 may be programmed to assert SRQ whenever operating conditions cause it to change from one mode to the other.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

The 4½ digit display shows actual output voltage, selected current limit, or actual output current. The actual output voltage is shown even when the PS 5004 is operating in the current-limited or unregulated mode. Display resolution is 1 mV or 0.1 mA.

The buffered high-impedance sense terminals allow proper regulation of the supply with up to 3 Ω of resistance in either of the sense leads.

## CHARACTERISTICS

### CONSTANT VOLTAGE MODE

**Range** — 0 V to 20 V in 0.5 mV steps.

**Overall Accuracy (Total Effect)** — ±0.01% +2 mV from +15°C to +30°C, derating to ±0.035% +3 mV at 0°C and +50°C. Source Effect: 500 μV. Load Effect: 1 mV for a no load to full load change in load current measured at sense terminals.

**Step Size Accuracy** — 0.5 mV ±0.2 mV.

**PARD*[1]** — ≤2 mV p-p, 10 Hz to 5 MHz.

**Load Transient Recovery*[1] *[2]** — <200 μs to recover within 5.0 mV of final value for a 100 mA load change.

*[1] *Characteristics measured at front panel terminals without using remote sense.*

*[2] *Without external energy storage components.*

### CONSTANT CURRENT MODE

**Range** — 10 mA to 305 mA in 2.5 mA steps.

**Overall Accuracy** — ±2% +5 mA.

### DIGITAL METER

**Configuration** — True 4½ digit free running voltmeter. Meter can be selected by front panel controls or via GPIB to monitor output voltage, current or current limit setting. Measurements are displayed on the front panel and are available over the GPIB.

**Resolution** — 1 mV or 0.1 mA.

**Accuracy** — Output Voltage: ±0.15% +6 mV. Output Current: ±1.5% +1 mA. Current Limit: ±1.5% +5 mA.

**Reading Rate** — ≈5/s.

### OTHER CHARACTERISTICS

**Isolation Voltage (Maximum Allowable Voltage Between Any Output or Sense Terminal and Chassis Ground)** — 42 V peak ac + dc.

**TM 5000 Power Module Compatibility** — The PS 5004 is not compatible with TM 500 mainframes.

**Power Consumption — Marketing**

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PP∅, DC1, DT1, C∅.

## ORDERING INFORMATION

**PS 5004** Precision Power Supply **$1,850**

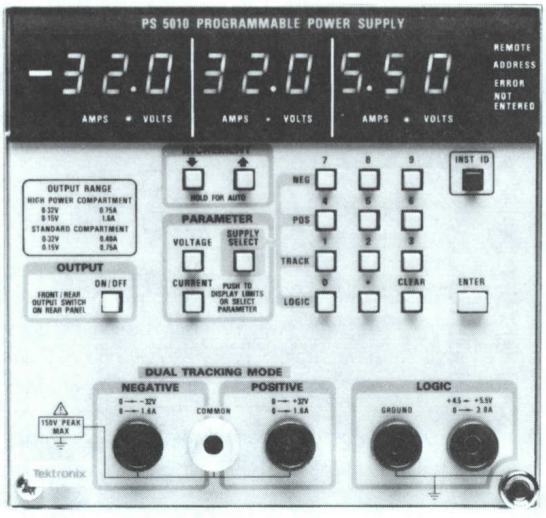
**Includes:** Instruction manual (070-4442-00); instruction interfacing guide (070-4789-00); reference guide (070-4596-00).

**Utility Software**

For TM 5000/4041 Order 062-6958-01 **$150**

See page 297 for description and ordering information.

**PS 5010**




**Programmable Triple Power Supply**

# PS 5010

GPIB IEEE-488

The PS 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Dual Floating Supplies 0 V to 32 V, to 0.75 A (1.6 A to 15 V)**

**Logic Supply +4.5 V to 5.5 V, to 3 A**

**0.5% Accuracy**

**Programmable Current Limits**

**Three Independent Digital Displays**

**Automatic Crossover**

The PS 5010 Programmable Power Supply provides a complete and rapid high performance solution for many system power supply applications. Its three supplies provide the most commonly used voltages, and the three digital displays automatically indicate all six voltage and current limit parameters. Automatic crossover from voltage to current limit and a powerful set of GPIB status reporting messages allow the user to be constantly aware of the PS 5010's status.

The PS 5010's dual floating supply provides 0 V to +32 V and 0 V to −32 V, both with respect to a common front-panel terminal. Or 0 V to 64 V across the terminals of both supplies together—with currents up to 0.75 A throughout the total voltage range and 1.6 A below 15 V. The logic supply provides +4.5 V to +5.5 V with respect to ground, with currents to 3 A. The user can program the outputs on and off, and can lock out the front panel controls with GPIB commands.

The three supplies can be independently programmed for separate voltage and current limits, and displayed in the LED display.

Whenever a load change causes a supply to change modes from constant voltage to constant current (or vice versa), the corresponding display also changes to show the known current or voltage value. This condition can be reported over the GPIB via an interrupt when the PS 5010 is in the remote state.

## CHARACTERISTICS

### POSITIVE AND NEGATIVE FLOATING SUPPLIES

**Configuration** — Dual floating with shared common terminal.

**Isolation** — 150 V peak front panel, 42 V peak from rear interface, 0.015 μF typical shunt capacitance to ground.

#### Constant Voltage Mode

**Range** — Positive: 0 V to +32.0 V. Negative: 0 V to −32.0 V.

**Overall Accuracy** — Total Effect: ±(0.5% + 20 mV). Source Effect: ± (0.01% +2 mV). Load Effect: ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

**PARD (Ripple and Noise)** — 10 mV p-p; 20 Hz to 20 MHz.

**Resolution** — 10 mV ±10 mV (typically ±2 mV) to 10.0 V. 100 mV ±40 mV (typically ±10 mV) >10.0 V.

**Load Transient Recovery** — 500 μs to recover within 20 mV of nominal value for a 1 A change.

**Change Response Time** — 1 ms for up or down change with maximum load, 20 ms for down change with no load.

#### Constant Current Mode

**Range** — 50 mA to 0.75 A (1.60 A at 15 V and below) in high power compartment; 50 mA to 400 mA (0.750 A at 15 V and below) in two standard power compartments.

**Overall Accuracy** — ±(5% + 20 mA) Source Effect: ±1 mA line regulation. Load Effect: ±10 mA. Output impedance is typically 5 kΩ shunted by 20 μF.

**PARD (Ripple and Noise)** — 10 mA p-p, 20 Hz to 20 MHz.

**Resolution** — 50 mA ±15 mA.

**Change Response Time** — 20 ms up or down.

### LOGIC SUPPLY

#### Constant Voltage Mode

**Range** — +4.50 V to +5.50 V, ground referenced.

**Overall Accuracy** — ±50 mV. Source Effect: ±1 mV. Load Effect: ±10 mV for 1 A load current change (1 mV when using rear interface output with remote sensing).

**PARD (Ripple and Noise)** — 10 mV p-p, 20 Hz to 20 MHz.

**Resolution** — 10 mV ±10 mV (typically ±2 mV).

**Load Transient Recovery** — 500 μs to recover within 20 mV of nominal value.

#### Constant Current Mode

**Range** — 100 mA to 3.0 A (Foldback characteristic below 4.5 V, maximum short circuit current is <1.5 A).

**Overall Accuracy** — ±(5% +20 mA).

**Resolution** — 100 mA ±30 mA.

**Scaled Output** — 10 mA ≙ 1 mV ±(2% +2 mV) available at rear interface (not ground referenced).

**Overvoltage Protection** — SCR crowbar typically trips at 6 V to 7 V.

### OTHER CHARACTERISTICS

**TM 5000 Power Module Compatibility** — The PS 5010 is not compatible with TM 500 mainframes.

**Power Consumption** — 250 VA maximum in high power compartment, 200 VA in standard compartment.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — Same as PS 5004.

## ORDERING INFORMATION

**PS 5010** Power Supply **$3,050**

**Includes:** Instruction manual (070-3391-00); instrument interfacing guide (070-4610-00); reference guide (070-3402-00).

**Utility Software**

For TM 5000/4041 Order 062-6958-01 **$150**

See page 297 for description and ordering information.

# SG 5010/AA 5001

GPIB IEEE-488

The SG 5010 and AA 5001 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Fast, Accurate, Repeatable Measurements**

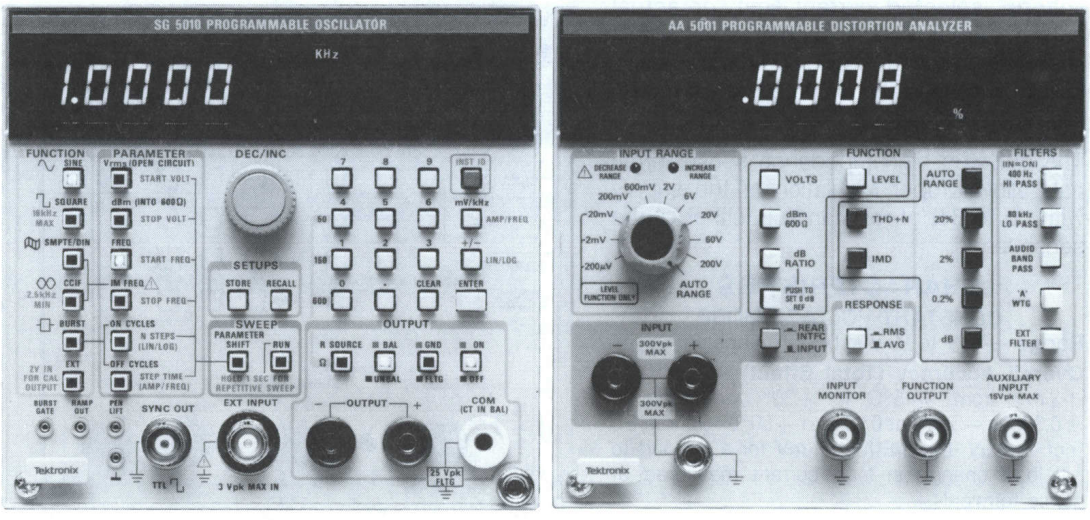
**Easy to Use, Minimizes Training Needs**

**Automatic Low-Cost Documentation of Test Results**

### Automated Audio Test System Advantages

Tektronix SG 5010 and AA 5001 programmable instruments in a computer-controlled test system will make critical audio measurements consistently, accurately, and in two to four seconds each. Even complex tests can be made by technically unskilled operators since the procedures are controlled by software in the controller. And, permanent graphic or tabular records of test results can be produced at very low cost.

**SG 5010** **AA 5001**




**Programmable Audio Test System**

An SG 5010/AA 5001 based system will automatically perform such industry-standard tests as harmonic distortion to IHF A202, intermodulation distortion to SMPTE TH 22.51, DIN 45403, IEC 268.3, and IHF A202, frequency response to IHF A202, and noise or signal-to-noise ratio to IHF A202 ("A" weighting filter complies with ANSI specification S1.4 and IEC specification 179 for sound level meters). With the Option 02 capability of the AA 5001, noise measurements may be made to CCIR 468-2 and DIN 45405 standards. The SG 5010 also generates the burst signal necessary for dynamic headroom tests per IHF A202.

A basic automated system consists of the SG 5010 Programmable Oscillator, the AA 5001 Programmable Distortion Analyzer, and an IEEE Standard 488 controller such as the Tektronix 4041 System Controller. Frequency counters, signal switchers, interface devices, disc storage, and hard copy units or plotters may be optionally added to the system.

The MP 2902 is a measurement package offering a total solution to your audio measurement requirements. It includes an automatic test program generator which dramatically reduces software development time and allows program development by nonprogrammers. See page 335.

### Other Measurement Capabilities

Features and flexibility of the SG 5010 and AA 5001 permit a variety of other measurements to be easily automated. SMPTE-like IMD measurements may be made at a variety of lower frequencies and any value of upper frequency, and at 1:1 amplitude ratios in addition to the standard 4:1 ratio. A CCIF test with the frequencies selected near the upper band limit of the device under test has been shown to be a very effective and simple-to-implement test for transient or dynamic intermodulation (TIM and DIM). Burst signals of any desired duty cycle may be generated for IHF dynamic headroom measurements and to test compressors and limiters; the between-bursts level may be selected as Off or 20 dB below the burst level. Power measurements are made by a controller computation from a voltage measurement across a known load resistance. SINAD measurements of sensitivity of FM communications receivers are a standard capability of the AA 5001 plus an appropriate RF signal generator. The SG 5010 features an amplifier mode in which an external signal can be converted to the high level, multiple impedance, balanced and floating capability of the SG 5010 output circuitry. Fully program-selectable filters in the AA 5001 allow various choices of bandwidth for distortion measurements and weighting for noise measurements, or rejection of interfering signals. Phase measurements can be added to the system by use of the DC 5009 or DC 5010 Universal Counter-Timer.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

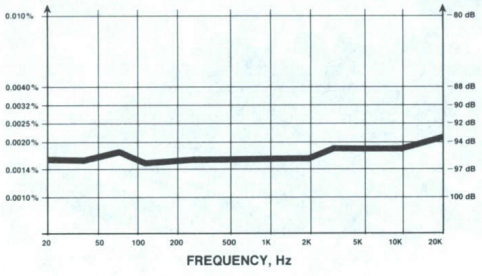
## SYSTEM CHARACTERISTICS

### HARMONIC DISTORTION FUNCTION

**Measurement Settling Time** — Typically ≤2.5 s above 100 Hz, increasing by 1 s/octave below 100 Hz.

**Residual THD + N** — $V_{in}$ ≥250 mV, RMS response, all distortion, noise, and nulling resources combined. 20 Hz to 20 kHz ≤0.0032% (−90 dB) with 80 kHz filter. 10 Hz to 100 kHz ≤0.01% (−80 dB) no filters.

**TYPICAL SYSTEM RESIDUAL THD + NOISE**
$V_{in}$ ≥250 mV with 80 kHz filter, RMS response.




### INTERMODULATION DISTORTION FUNCTION

**Measurement Settling Time** — Typically ≤2 s.

**Residual IMD** — $V_{in}$ ≥250 mV, RMS response.

**SMPTE and DIN Tests** — ≤0.0032% (−90 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 ratio.

**CCIF Difference Frequency Test** — ≤0.0018% (−95 dB) with 14 kHz and 15 kHz.

### LEVEL FUNCTION

**Measurement Settling Time** — Typically ≤2 s.

**Flatness** — ±0.1 dB 20 Hz to 20 kHz.

## SG 5010 CHARACTERISTICS

### AVAILABLE FUNCTIONS

Sinewave, squarewave, SMPTE/DIN 4:1, SMPTE DIN 1:1, CCIF, Sinewave Burst, IHF Burst (−20 dB or Off between bursts), External Input (Amplifier Mode).

### FREQUENCY RANGE AND ACCURACY

**Sinewave, Sinewave Burst**
SMPTE/DIN: 10 Hz to 163.80 kHz ±0.01%.
CCIF Center Frequency: 2.500 kHz to 163.80 kHz ±0.01%.
Squarewave: 10 Hz to 16.380 kHz ±0.01%.

**Resolution in Above Functions**
10.00 Hz to 163.80 Hz: 0.01 Hz. 163.9 Hz to 1.6380 kHz: 0.1 Hz. 1.639 kHz to 16.380 kHz: 1.0 Hz. 16.39 kHz to 163.80 kHz: 10.0 Hz.

**SMPTE Lower Tone, CCIF Offset From Center Frequency** — Selectable From: 40 Hz, 50 Hz, 60 Hz, 80 Hz, 100 Hz, 125 Hz, 250 Hz, 500 Hz, all ±2%.

**Sine Distortion (Load ≥600 Ω, THD Including 2nd Through 5th Harmonics)** — 20 Hz to 20 kHz: 0.001% (−100 dB). 20 kHz to 50 kHz: 0.0032% (−90 dB). 10 Hz to 20 Hz and 50 kHz to 100 kHz: 0.01% (−80 dB). 100 kHz to 163.8 kHz: 0.032% (−70 dB) any individual harmonic.

**SMPTE, DIN or CCIF Distortion** — See System Specifications.

**Sine Flatness** — 20 Hz to 20 kHz: ±0.05 dB. 10 Hz to 163.8 kHz: ±0.2 dB.

**Squarewave Risetime** — 1.5 µs ±10%.

**Burst Range** — 1 cycle to 65535 cycles On. 1 cycle to 65535 cycles Off. Off level either −20 dB or zero. All switching at sinewave zero crossing. Triggered, gated, or free-running burst modes available.

### OUTPUT LEVEL RANGE AND ACCURACY

**Balanced** — Into Open Circuit: 200 µV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +28.05 dBm.*1

**Unbalanced** — Into Open Circuit: 200 µV to 21.2 V RMS. Into 600 Ω: −72.45 dBm to +22.05 dBm.*1

**Resolution** — 0.05 dB in dBm mode, 0.25% or better in volts mode.

**Level Accuracy (Sinewave)** — 20 Hz to 20 kHz ±2% (0.2 dB). 10 Hz to 163.8 kHz ±3 (0.3 dB).

*1 *$R_S$ = 50 Ω. For $R_S$ = 150 Ω, subtract 1.25 dBm; for $R_S$ = 600 Ω, subtract 5.35 dBm.*

### OUTPUT IMPEDANCE AND CONFIGURATION

50 Ω ±3%, 150 Ω ±2%, or 600 Ω ±1%, balanced or unbalanced, floating or grounded.

### EXTERNAL INPUT

A floating single-ended input is provided for accessing the variable gain stage and high level output amplifier, enabling the use of custom test signals. Input impedance is 20 kΩ; a 2 V RMS input (2.83 V peak maximum) provides a calibrated output.

### SYNC OUTPUT

A ground referenced TTL compatible signal is provided which allows stable oscilloscope display of all functions. In sine and squarewave modes the output is at the signal frequency. In the IM modes the sync output is at the lower or offset frequency. In both burst modes the sync signal follows the burst envelope.

### SWEEP MODE

Linear or logarithmic sweep of amplitude or frequency in any function. Sweep is composed of discrete steps. The following sweep functions are programmable via GPIB or from the front panel: swept parameter (frequency or amplitude), linear or log sweep, number of steps up to 99, time per step from 0.1 s to 25 s, start frequency or voltage, and stop frequency or voltage. Start and stop frequencies or voltages may be anywhere within the range of the generator, and sweep direction may be upward or downward. Pen lift and ramp outputs are available for interface to an analog plotter.

### STORED SETUPS

Ten different complete front panel setups may be stored in the nonvolatile internal memory and recalled from front panel push buttons or via the GPIB. Additionally, the front panel settings at power down are retained and used at power up.

### PROGRAMMABILITY

All functions, parameters, and modes may be controlled over the GPIB using simple English-like commands. All settings may be interrogated, with the resulting response usable as a command to return the instrument to that setting (Learn mode). The GPIB address may be displayed and changed from the front panel.

**GPIB Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PPØ, DC1, DT1, CØ.

## AA 5001 CHARACTERISTICS

### HARMONIC DISTORTION FUNCTION

**Fundamental Frequency Range** — 10 Hz to 100 kHz, automatically tuned to input frequency.

**Distortion Ranges** — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

**Accuracy** — 20 Hz to 20 kHz is ±1 dB. 10 Hz to 100 kHz is +1, −2 dB. (Accuracy is limited by residual THD + N and filter selection.)

**Fundamental Rejection** — At least 10 dB below specified residual THD + N or actual signal THD, whichever is greater.

**Minimum Input Level** — 60 mV (−22 dBm).

### LEVEL FUNCTION

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

**Modes** — Volts, dBm (600 Ω), or dB ratio with push-to-set 0 dB reference.

**Level Ranges** — 200 µV full scale to 200 V full scale in ten steps, manual or autoranging.

**Accuracy**

| Frequency | Volts | dBm or dB Ratio |
|---|---|---|
| 20 Hz to 20 kHz | ±2%<br>±1 count | ±0.3 dB*1<br>+0.5% of reading |
| 10 Hz to 100 kHz | ±4%<br>±2 counts | ±0.5 dB*1<br>+0.5% of reading |

*1 *$V_{in}$ ≥ 100 µV, level ranging indicators extinguished. ±0.2 dB at 1 kHz only. Flatness is ±0.1 dB, 20 Hz to 20 kHz, and ±0.3 dB, 10 Hz to 100 kHz.*

**Bandwidth** — ≥300 kHz.

**Residual Noise** —
≤3 µV (−108 dBm) with 80 kHz and 400 Hz filters, RMS response.
≤1.5 µV (−114 dBm) with "A" weighting filter, RMS response (standard instrument only).
≤5 µV (−104 dBm) with CCIR weighting filter, quasi-peak response (Option 02 instrument only).

### INTERMODULATION DISTORTION FUNCTION

Fully automatic SMPTE, DIN, and CCIF difference tone measurements. Minimum input level 60 mV (−22 dBm). Accuracy ±1 dB.

**SMPTE and DIN Tests** — Lower Frequency Range: 50 Hz to 500 Hz. Upper Frequency Range: Usable from 3 kHz to 163.8 kHz. Level Ratio Range: 1:1 to 4:1 (lower:upper). Residual IMD: See System Specifications.

**CCIF Difference Frequency Test** — Frequency Range: Usable from 4 kHz to 163.8 kHz. Difference Frequency Range: 80 Hz to 1 kHz. Residual IMD: See System Specifications.

### ALL FUNCTIONS

**Display** — 3 1/2 digits resolution at ≈3 readings/s.

**Detection** — Average or true RMS for waveforms with crest factors ≤3. Option 02 replaces average detector with quasi-peak detector complying with CCIR Recommendation 468-2 and DIN 45405.

**Filters** —
400 Hz High Pass: −3 dB at 400 Hz ±5%: 18 dB octave slope, at least 40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%; 18 dB/octave slope.

Audio Bandpass: −3 dB at 22.4 Hz and 22.4 kHz, both ±5%. Complies with CCIR Recommendation 468-2 and DIN 45405.
"A" Weighting: Meets specifications for Type one sound level meters (ANSI S1.4, IEC Recommendation 179). Option 02 replaces "A" weighting filter with CCIR weighting filter complying with CCIR Recommendation 468-2 and DIN 45405.
Ext: Allows connection of external filters.

**Input Type** — Balanced (full differential).

**Input Impedance** — 100 kΩ ±2%, each side to ground.

**Maximum Input** — 300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.

**Common-Mode Rejection** — ≥50 dB at 50 Hz or 60 Hz. Typically ≥40 dB to 300 kHz.

### PROGRAMMABILITY

Function (Level or THD or IMD). Level Mode (Volts or dBm). Input Level and Distortion Ranges (Autorange or default to range selected by front panel switches).
Detector Type (RMS or AVG; or RMS or Q-PK on Option 02).
Filter Selection (400 Hz Hi Pass, 80 kHz Low Pass, 22.4 Hz to 22.4 kHz Band-Pass, "A" Weight (or CCIR WTG on Option 02, Ext Filter).

**GPIB Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RL1, PPØ, DC1, DTØ, CØ.

### FRONT PANEL SIGNALS

**Input Monitor** — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.

**Function Output** — Provides a scaled sample of selected function signal. Output Voltage: 1 V RMS ±3% for 1000 count display. Source Impedance: 1 kΩ ±5%.

**Auxiliary Input** — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

### REAR INTERFACE SIGNALS

Duplicates of all front panel inputs and outputs are provided to allow external filter connections or oscilloscope monitoring within same mainframe without exposed cables. Detector outputs with specified scale factors also available to drive analog chart recorders, storage oscilloscopes, or similar devices.

### ORDERING INFORMATION

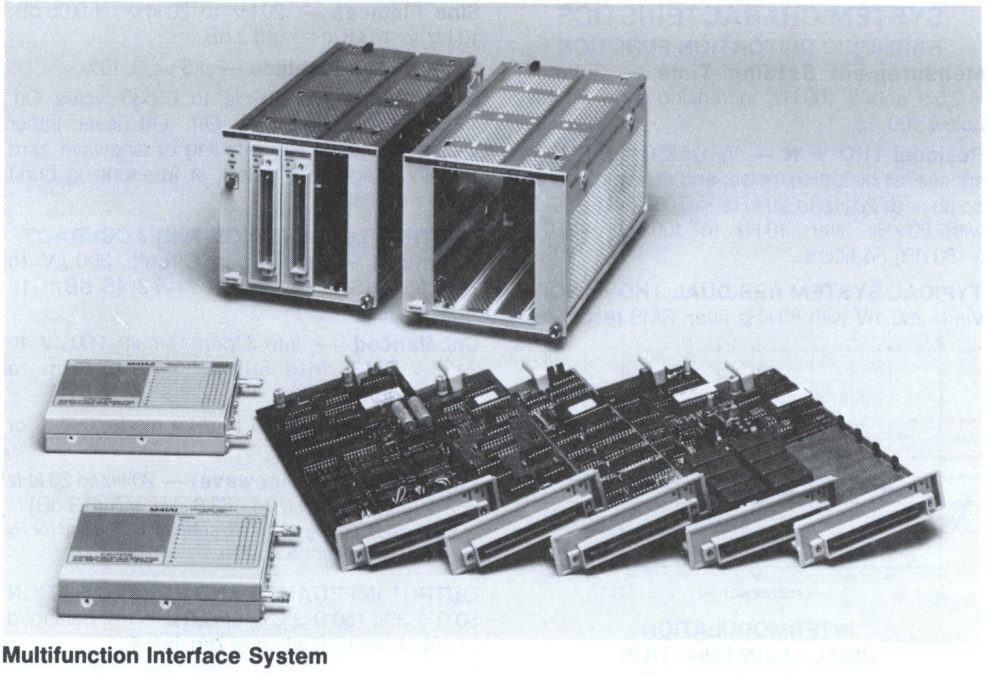
**SG 5010** Programmable Oscillator **$4,195**
**Includes:** Instruction manual (070-4331-00); instrument interface guide (070-4790-00); reference guide (070-4330-00).

**AA 5001** Programmable Distortion Analyzer **$3,450**
**Includes:** Instruction manual (070-4598-01); instrument interface guide (070-4788-00); reference guide (070-4597-00).

**Option 02** — CCIR/DIN. **+$410**

**Audio Test Program Generator Software** — Order S45F902 **$1,995**

**Utility Software**
For TM 5000/4041 Order 062-6958-01 **$150**
See page 297 for description and ordering information.



**Multifunction Interface System**

# MI 5010/MX 5010

GPIB IEEE-488

The MI 5010 and MX 5010 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

- **Wide Range of System Interfacing Functions**
- **Up to Six Functions at One Address**
- **D-to-A, A-to-D Conversion**
- **Low-Level Signal Scanning**
- **Digital I/O**
- **Digital Word Acquisition and Generation**
- **Built-In Time-of-Day and Pacing Clock**
- **Command Buffer for Controller-Free Operation**
- **Thermocouple Scanning**

The MI 5010/MX 5010 Multifunction Interface System consists of the MI 5010 Multifunction Interface, the MX 5010 Multifunction Interface Extender, and seven different types of function cards. These cards are capable of a variety of functions typically required in automated test system interfacing, data acquisition and generation, and process control.

The MI 5010 and MX 5010 each house up to three function cards, in any combination. The MI 5010 provides the means of communication between the system controller and the function cards. The MX 5010 is always used in connection with an MI 5010, extending its control to six function cards at one GPIB address.

The function cards presently available for the MI 5010/MX 5010 Multifunction Interface System are: 50M10 Analog-to-Digital Converter, 50M20 Digital-to-Analog Converter, 50M30 Digital I/O, 50M40 Relay Scanner, 50M41 Low-Level Scanner (with M41A1 through M41A8 Signal Conditioners), 50M50 Memory, and 50M70 Development card. Each function card contains its own ROM with the specific firmware and its own unique set of commands required for its particular function. Each card may be operated in any slot of the MI 5010 and/or MX 5010 regardless of the other cards in the system.

In addition to providing the interface between the function cards and the system controller, the MI 5010 also has its own intelligence and a built-in command buffer. This buffer is capable of storing up to 300 system commands and executing them in sequence, paced by the on-board time-of-day and pacing clock or by signals from the system under test. It requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

**IEEE Standard 488-1978 Interface Function Subsets Implemented** — SH1, AH1, T6, L4, SR1, RLØ, PPØ, DC1, DT1, CØ.

### ORDERING INFORMATION

**MI 5010** Multifunction Interface **$1,760**
**Includes:** Instruction manual (070-3712-00); instrument interface guide (070-5187-00); reference guide (070-3882-00).

**MX 5010** Interface Extender **$740**
**Includes:** Same as above.

**Utility Software**
For TM 5000/4041 Order 062-6958-01 **$150**
See page 297 for description and ordering information.
This utility software supports all of the 50Mxx Series function cards also.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

# 50M10

**Programmable A/D Converter**

**12-Bit Resolution**

**32 μs Conversion Time**

**Four Voltage Ranges ±100 mV to ±100 V**

**Data Transfer via GPIB or Front Panel Connector**

The 50M10 uses a 12-bit successive approximation conversion technique with a track-and-hold amplifier to achieve a total conversion time of 32 microseconds or less (approximately 30,000 conversions per second). Using the front panel connector, conversion values may be sent over the GPIB (via the MI 5010) or to external memory devices (such as the 50M50 Memory card). In either case, data is transferred in two eight-bit bytes. The lower six bits contain the converted value, high byte followed by low byte. The seventh bit is a high-low byte indicator. The eighth bit is unused.

Four voltage ranges are provided, manually selectable by on-board jumpers: +100 mV, +1 V, +10 V and +100 V. The total span for each range is divided into 4096 parts (12-bits). The front panel analog input connections (high and low) may be elevated to a potential of +340 volts, dc plus peak ac.

Two handshaking modes are provided, one for communication with devices faster than the 50M10 (the device can accept data as fast as the 50M10 can provide it), and the other for communication with devices slower than the 50M10 (the 50M10 must be clocked by the external receiving device). Front panel control lines permit the 50M10 conversions to be triggered, gated, or triggered within a gate. Through the use of a gateable function generator, such as the Tektronix FG 501A, and a digital delay generator, such as the Tektronix DD 501, a counted burst of conversions at a selected rate can be gated.

## CHARACTERISTICS

**Maximum Conversion Rate** — 32 μs.

**Maximum Aperture Time** — ≤400 ns.

**Accuracy**

| Range | +18°C to +28°C | 0°C to +50°C |
|---|---|---|
| 100 mV | ±0.15%*[1] | ±0.25%*[1] |
| 1 V and 10 V | ±0.075%*[1] | ±0.125%*[1] |
| 100 V | ±0.125%*[1] | ±0.2%*[1] |

*[1] *Full scale.*

**Amplifier Settling Time** — 100 mV Range: ≤150 μs. 1 V Range: ≤25 μs. 10 V Range: ≤10 μs. 100 V Range: ≤30 μs.

**Input Impedance** — 100 mV, 1 V and 10 V Ranges: $\geq 10^{10}$ Ω. 100 V Range: ≥1 MΩ.

**Digital Data Transfer Format** — 12-bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

## ORDERING INFORMATION

**50M10** Analog-to-Digital Converter Card **$895**

**Includes:** Interfacing cable (015-0430-00); instruction manual (070-4495-00); reference guide (070-4491-00).

# 50M20

**Programmable D/A Converter**

**12-Bit Resolution**

**Voltage or Current Mode**

**20 μs (Maximum) Conversion Time**

**250 V RMS Isolation**

**Mnemonic Instructions**

**Self-Test and Error Indicators**

**UL 1244 Listed**

The 50M20 converts digital data to either analog voltage or current. The voltage or current mode is selectable manually via an on-board switch.

Data format is 12 bits, sent in two sequential 7-bit words. Data may be sent via the IEEE Standard 488 (GPIB) using the MI 5010 as the interface, or from an external (front connector) bus for high speed data transfer (with appropriate handshake lines). On-board firmware will convert commands and data to the proper format to perform the required digital-to-analog conversion. Two lines at the front panel connector are provided to handshake data into the 50M20 from the user's external system.

Programming of the 50M20 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M20, control the source and the format of the digital data. The 50M20 may be programmed to respond to either external or internal system triggers.

## CHARACTERISTICS

### VOLTAGE MODE

**Range** — −10.240 V to +10.235 V.

**Accuracy** — ±10.0 mV (+20°C to +30°C) ±15 mV (0°C to +50°C).

**Resolution (1 LSB)** — 5 mV.

**Total Conversion Time (Maximum)** — 20 μs.

**Output Ripple and Noise** — <5 mV p-p at 5 MHz BW.

**Output Current Range** — 0 mA to ±5 mA.

### CURRENT MODE

**Range** — −20.48 mA to +20.47 mA.

**Accuracy** — ±20 μA (+20°C to +30°C) ±40 μA (0°C to +50°C).

**Resolution (1 LSB)** — 10 μA.

**Total Conversion Time (Maximum)** — 20 μs.

**Output Ripple and Noise** — <15 μA, p-p, at 5 MHz BW.

**Compliance Voltage** — ±11 V.

**Isolation** — 250 V RMS maximum to ground.

**Digital Data Transfer Format** — 12-bit word transferred in two bytes, high byte first. Lower six bits of each byte contain data, seventh bit is high byte/low byte indicator, eighth bit is unused.

## ORDERING INFORMATION

**50M20** Digital-to-Analog Converter Card **$910**

**Includes:** Interfacing cable (015-0430-00); instruction manual (070-3724-01); reference guide (070-3883-00).

# 50M30

**Programmable Digital Input/Output Card**

**16 Digital Input and 16 Digital Output Lines**

**Data Entry/Output Formats in Decimal, Binary, or Hex**

**Triggered Externally or On Command**

**Mnemonic Instructions**

**Self-Test and Error Indicator**

**UL 1244 Listed**

The 50M30 provides 16 digital input and 16 digital output lines. The digital inputs accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. The digital outputs provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The digital outputs can be configured for open-collector outputs by positioning internal jumpers and using power supplied by the user.

Programming of the 50M30 is via the IEEE Standard 488 (GPIB) Bus. System commands sent to the MI 5010 Microprocessor, along with specialized programming commands unique to the 50M30, control the selection of the data input/output channels and the arming/trigger functions of the card.

Four lines at the front panel connector operate as input/output pairs to handshake data with the user's external system. One handshake pair allows the user's data source to be synchronized with the 50M30 data input register and the other handshake pair allows the user's data storage device to be synchronized with the 50M30 data output register.

## CHARACTERISTICS

**Data Outputs Using Internal Supply** — 16 open-collector TTL with 2 kΩ pullup resistors. Logical "1": +5 V ±2% (open circuit). Source current is −2.5 mA ±7% maximum. Logical "0": 0.2 V. Sink current is −40 mA maximum.

**Data Outputs Using External (User) Supply** — Maximum Voltage: +15 V. Pullup Resistors: 2 kΩ. Logical "1" equal to external supply voltage (open circuit). Source current is 7.5 mA ±5% plus external supply tolerance. Logical "0": 0.2 V. Sink current is 40 mA maximum.

**Data Inputs** — Input Buffers: 16 Schmitt triggers. Logical "1" (+V Threshold): +1.6 V ±25%. Source current is −0.14 mA nominal, −0.16 mA maximum. Logical "0" (−V Threshold): +0.8 V ±40%. Source current is −0.18 mA nominal, −0.21 mA maximum.

## ORDERING INFORMATION

**50M30** Digital Input/Output Card **$495**

**Includes:** Interfacing cable (015-0430-00); instruction manual (070-3722-00); reference guide (070-3884-00).

GPIB

## 50M40

**Programmable Relay Scanner Card**

**16 Mercury Wetted Relay Contacts**

**User Configurable 1, 2, 4 Groups**

**Triggered Externally or On Command**

**Mnemonic Instructions**

**Self-Test and Error Indicators**

**UL 1244 Listed**

The 50M40 provides 16 independent, normally-open relay contacts. The relay contacts may be used as switch closures to supply power to several external points from one source, or scan several sources and supply various inputs to a single measurement device.

The desired relay switch pattern is configured by the user with internal jumpers. When the configuration has been established, the relay scanning sequence, open and close operations, and triggering events are programmed over the IEEE Standard 488 GPIB Bus.

Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close. Three possible configurations are:

4 groups of 4 individual relays
2 groups of 8 individual relays
1 group of 16 individual relays

Scanning sequence and relay closure is accomplished under program control. Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close.

### CHARACTERISTICS

**Type of Relays** — Mercury wetted reed.

**Possible Configurations (Jumper Selectable)** — 1 of 4, 4 each. 1 of 8, 2 each. 1 of 16, 1 of 12 and 1 of 4, 1 each.

**Maximum Applied Voltage** — 40 V dc plus peak ac.

**Maximum Carry Current** — 1 A.

**Breakdown Voltage** — 100 V dc plus peak ac.

**Contact Resistance** — 0.15 Ω nominal (end of life).

### ORDERING INFORMATION

**50M40** Relay Scanner Card **$695**

**Includes:** Interfacing cable (015-0430-00); instruction manual (070-3723-00); reference guide (070-3885-00).

## 50M41

**Programmable Low-Level Scanner**

**10 Differential Contact Pairs Plus Guard**

**<1 μV Low Thermal Offset**

**User Configurable**

**Handshake Lines to Permit External Control**

**Isothermal Amplifiers Available for Thermocouple Applications**

The 50M41 provides ten pairs of guarded, normally open relay contacts with less than one microvolt of thermal offset in each channel. Each differential pair of contacts is accompanied by a third contact to switch the shield or guard connection. The ten sets of relay contacts can be configured as two groups of five individual relays with two commons, or as one group of ten individual relays with one common. The desired relay switch pattern is configured by internal jumpers. A tree relay can be included in the 1 of 10 configuration to reduce capacitive loading and potential noise problems when using more than one 50M41 in a system. Two handshake lines are provided for externally controlling the 50M41.

A family of high-gain, low-noise signal conditioning modules—M41A1 through M41A8—is available to condition low-level signals for specialized applications with the 50M41.

### CHARACTERISTICS

**Type of Relays** — 10 sealed low-thermal-EMF relays configurable as one 10-to-1 switch or two 5-to-1 switches.

**Thermal Offset** — <1 μV differential; <2 μV differential with tree switch.

**Maximum Scan Rate** — ≥200 cycles/s.

**Maximum Applied Voltage (High, Low or Guard of Any Channel to Chassis)** — 350 V dc + peak ac.

**Maximum Switched Voltage** — 150 V dc + peak ac (not to exceed VA rating).

**Maximum Carry Current** — 250 mA.

**Maximum Switched Current** — 10 mA.

**Maximum Switched VA** — 0.15 VA.

### ORDERING INFORMATION

**50M41** Low Level Scanner Card **$995**

**Includes:** Interfacing cable (015-0430-00); instruction manual (070-4557-00); reference guide (070-4556-00).

## M41A1

**Low Level Amplifier for 50M41**

**10 Differential Inputs plus Guard**

**Selectable Gains of 1, 10, 100, and 1000**

**Software Selectable Filter**

**External Handshake Lines**

**50M41 Low Level Scanner Required**

The M41A1 is a general purpose amplifier with switchable gain in decade steps from 1 to 1000. Provision is made for a guarded input that can be driven by the amplifier's guard driver or by an external signal source. A software selectable low-pass filter with a corner frequency of approximately 4 Hz provides more than 60 dB of normal mode rejection at 60 Hz. The frequency response with the filter turned off is approximately −3 dB at 10 kHz.

### CHARACTERISTICS

**Gain Ranges**

| Overall Gain (A) | Input Gain (A) | Buffer AMPL Gain | Output Dynamic Range |
|---|---|---|---|
| 1000 | 1000 | 1 | 10 V |
| 100 | 1000 | 0.1 | 1 V |
| 100 | 100 | 1 | 10 V |
| 10 | 100 | 0.1 | 1 V |
| 10 | 10 | 1 | 10 V |
| 1 | 10 | 0.1 | 1 V |

**Gain Accuracy** — ± 0.1% from +18°C to +28°C; ± 0.2% from 0°C to +50°C

**Maximum Input Voltage (Respect to System Ground)** — 250 V ac RMS (350 V dc + peak ac)

**Input Resistance Differential** — >10 MΩ paralleled with 0.05 μF capacitor.

**RMS Noise (Referred to the Input)** — <60 nV/$\sqrt{Hz}$ A=1000. <200 nV/$\sqrt{Hz}$ A=100. <500 nV/$\sqrt{Hz}$ A=10.

#### FILTER

**Bandwidth Filter On** — f(−3 dB): ≤6 Hz. f(−60 dB): ≤60 Hz.

**Bandwidth Filter Off** — >10 kHz.

**Settling Time** — Filter On: ≤400 ms. Filter Off: ≤150 μs.

### ORDERING INFORMATION

**M41A1** Low Level Amplifier **$550**

**Includes:** Instruction manual (070-4605-01).

INTERFACE PRODUCTS



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

# M41A2 through M41A8

## Thermocouple Amplifiers for 50M41

**10 Guarded Inputs**
**Selectable Hardware or Software Temperature Compensation**
**Software Selectable Filter**
**External Handshake Lines**
**50M41 Low Level Scanner Required**

Signal conditioning modules M41A2 through M41A8 are thermocouple amplifiers, each designed to operate with a specific thermocouple type (J, K, E, T, S, R, and B, respectively). The thermocouple amplifier provides isothermal connections for up to ten guarded or unguarded thermocouple pairs. Each amplifier provides hardware compensation for its specific thermocouple type; provision for software compensation is made where all thermocouples are not of the same type. Thermocouples are available from your local supplier.

### CHARACTERISTICS

**Maximum Thermocouple Wire Resistance —** 10 kΩ.

**Linearity Error —** ±0.02% or 1 μV referred to input (whichever is greater).

**Common Mode Rejection Ratio —** Incremental Dc: ⩾100 dB. 60 Hz: ⩾100 dB.

**Input Dynamic Range (Common Mode) —** ±10 V.

**Incremental Input Resistance (High to LO) —** >10 MΩ paralleled by 0.05 μF capacitor.

#### FILTER

**Bandwidth Filter On —** f(−3 dB): ⩽6 Hz. f(−60 dB): ⩽60 Hz.

**Setting Time —** Filter On: ⩽400 ms. Filter Off: ⩽150 μs.

#### ISOTHERMAL BLOCK

**Temperature Gradient —** <0.1°C between any two terminals or any terminal and temperature sensor.

**Hardware Compensation —** ±0.014 (V −Viso) A (°C) and 0.35°C (0°C to +50°C) or 0.25C (+18°C to +28°C).

**Software Compensation —** 0.35C (0°C to +50°C) or 0.25C (+18°C to +28°C)

### ORDERING INFORMATION

The following thermocouple amplifiers each include instruction manual 070-4605-01.

| | |
|---|---|
| **M41A2** Type J | **$625** |
| **M41A3** Type K | **$625** |
| **M41A4** Type E | **$625** |
| **M41A5** Type T | **$625** |
| **M41A6** Type S | **$625** |
| **M41A7** Type R | **$625** |
| **M41A8** Type B | **$625** |

# 50M50

## Programmable Memory Card

**16 kbyte Digital Input/Output**
**Single 16-Bit or Dual 8-Bit Channels**
**Independent Dual-Channel Operation**
**200 kHz Acquisition or Generation Rate**
**TTL Levels**
**External Handshake Lines**

The 50M50 is a 16 kbyte digital input/output device which can be configured, under program control, as a single 16-bit input/output port or as two 8-bit input/output ports. These ports can be connected to any of 16 data buffers which can be programmed to different lengths. The total memory of all the buffers cannot exceed 16 kbytes of storage.

The 50M50 is intended to be used as a digital word generator and/or as a fast, digital data acquisition buffer. As a digital word generator, the 50M50 can be used with a digital-to-analog converter, such as the Tektronix 50M20, to function as an arbitrary waveform generator. As a high speed data acquisition buffer, the 50M50 can be used with an analog-to-digital converter, such as the Tektronix 50M10, as an off-line, high-speed analog signal measurement system or as a waveform digitizer.

The 50M50 can be programmed to input or output data on two different channels simultaneously, or to input data on one channel while outputing data on the other channel. System commands to the 50M50 control the selection of input/output channels, the control of the data buffers, and the arming functions of the card.

Four handshake lines are provided at the front panel to permit synchronization with the user's external system (one pair for each channel). Other external control lines permit pacing and control of data output and disabling of data input.

### CHARACTERISTICS

**Data Outputs —** 8 or 16 low-power Schottky TTL lines. Logical "1": +5 V ±2% (open circuit). Source current is 2.5 mA +2% −7% maximum. Logical "0": ⩽0.7 V. Sink current is 40 mA maximum.

**Data Inputs —** 8 or 16 low-power Schottky TTL lines. Logical "1" (+V Threshold): +1.5 V to +2 V. Source current is −0.16 mA maximum. Logical "0" (−V Threshold): +0.6 V to +1.1 V. Source current is −0.21 mA maximum.

**Maximum Data Transfer Rate —** 8-Bit Bytes: 200 kHz ±2%. 16-Bit Bytes: 125 kHz ±2%.

### ORDERING INFORMATION

**50M50** Memory Card **$995**

**Includes:** Interfacing cable (015-0430-00); instruction manual (070-4550-00); reference guide (070-4554-00).

# 50M70

## Programmable Development Card

**32 Data I/O Ports**
**Interrupt and Trigger Lines**
**Vector Board Development Region**
**Mnemonic Instructions**
**Self-Test and Error Indicator**

The 50M70 provides the user with the means of developing his own unique circuit and interfacing it to the GPIB without the need for designing and building the GPIB interface itself. With the 50M70, the user may create a specialized function card to be used in the MI 5010/MX5010 Multifunction Interface System. When completed, the circuit can be programmed in high level language over the GPIB.

The 50M70 contains two 68B21 16-bit interface logic registers (PIAs), address and data buffers, its own firmware, and a 4x4 inch breadboard area for circuit development. The 32 data lines of the PIAs can be individually programmed as inputs or outputs. The PIAs also provide three sets of programmable two-wire handshake lines to permit triggering of the external system by the 50M70 or of the 50M70 by the external system.

Typical 50M70 applications are specialized A/D and D/A converter functions, counter/timer applications, special communication interface functions, keyboard and display functions, digital comparators for triggering and interrupt functions, etc.

### CHARACTERISTICS

**Data Input/Outputs and Handshake Lines —** Output High Level: +2.4 V minimum, +5.5 V maximum. Maximum Load Current: −200 μA. Output Low Level: 0 V minimum, +0.4 V maximum. Maximum Sink Current: 3.2 mA. Input Load Current: 1.3 mA nominal, 2.4 mA maximum.

**Dc Voltage Sources Available on the Card —** +26 V and −26 V ±9%, 100 mA maximum; +8 V ±5%, 600 mA maximum; +5 V ±5%, 1.5 A maximum. Total Combined Power Limit: 7.5 W.

## MULTIFUNCTION INTERFACE SYSTEM OPTIONAL ACCESSORIES

**Interfacing Cable** — 50-conductor flat ribbon cable with connector to mate with front panel connector of any Multifunction Interface System function card. Other end of the 48-inch cable terminates in bare tinned leads. (This cable is a standard accessory with 50M20, 50M30, 50M40, and 50M70 cards.)
Order 015-0430-00 **$65**

**Single-Width Interfacing Adaptor** — Mates with any single Multifunction Interface System function card to permit customized interface wiring between cards or to external system under test. Will accommodate up to five screw terminal blocks (131-3083-00 below).
Order 015-0466-00 **$125**

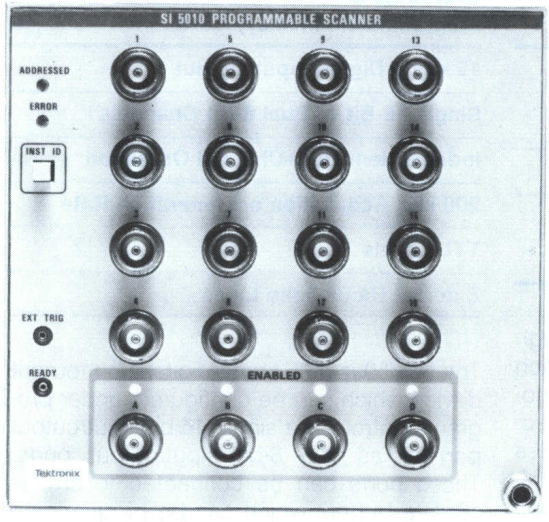
**Screw Terminal Block** — Mounts in 015-0466-00 Interfacing adaptor above to permit wiring changes without soldering (ten terminals per block). Order 131-3083-00 **$9.25**

**Triple-Width Interfacing Adaptor** — Mates with up to three Multifunction Interface System function cards in an MI 5010 or MX 5010 to permit interface wiring among cards or to external system under test. Contains two 131-3083-00 screw terminal blocks.
Order 015-0473-00 **$200**

**Multifunction Interface System Card Extender** — Permits operation of a function card while extended from the front of an MI 5010 or MX 5010. Order 067-1066-00 **$150**

**Function Card Access Shield** — Dummy function card of insulating material to protect against possible electrical shock or damage in partially filled MI 5010 or MX 5010.
Order 020-0836-00 **$41**

**SI 5010**




**Programmable Scanner**

# SI 5010

GPIB IEEE-488

The SI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Software Configurable as:**
- **1 Group of 16 Channels**
- **2 Groups of 8 Channels**
- **4 Groups of 4 Channels**

**350 MHz Bandwidth in 4-Channel Configuration**

**External Handshake Lines**

**Built-In Time-of-Day and Pacing Clock**

**Command Buffer for Controller-Free Operation**

The SI 5010 Programmable Scanner provides the capability of switching and routing up to 16 high frequency input and/or output signals. It always maintains a clean 50-ohm environment through the use of 50-ohm coaxial reed relays. The software-configurable basic four-channel arrangement allows the SI 5010 to be used for point-to-point switching (any connector to any other connector), or to be used in a wide variety of fan-in and/or fan-out configurations.

The SI 5010 has its own intelligence and a built-in command buffer capable of storing up to 300 system commands and executing them in sequence. It is paced by the on-board time-of-day and pacing clock or by signals from the system under test. This requires no interference from the system controller, thus freeing the controller to direct activity elsewhere in the system.

Two handshake lines are provided for externally controlling the SI 5010. An Ext Trig line is provided to allow the SI 5010 switching to be initiated by the external system under test, and a Ready line indicates to the external system when the relays have settled.

## CHARACTERISTICS

**RF Connectors** — 20 BNC connectors, 16 channels and four commons.

**Control Input (Ext Trig)** — External Trigger: TTL compatible

**Control Output Data Accepted (Ready)** — TTL compatible. Output goes high when relays have settled.

**Channel Configuration (Software Selectable)** — 1, 2, 3, or 4 groups of 4 channels. 2 groups of 8 channels. 1 group of 16 channels.

**Frequency Response** — Any 1 Group of 4: −3 dB at 350 MHz, decreasing to −6 dB at 500 MHz or greater. Any 1 Group of 8: −3 dB at 175 MHz or greater. Any 1 Group of 16: −3 dB at 80 MHz or greater.

**Port (Channel) Isolation** — 40 dB at 100 MHz.

**Characteristic Impedance (Each Channel)** — 50 Ω. See vswr specification.

**Risetime (Each Channel)** — <1 ns.

**Voltage Standing Wave Ratio (vswr)** — Any 4 Channel Group: 1.25:1 at 100 MHz, increasing to 1.8:1 at 350 MHz. Any Other Combination: 1.5:1 at 100 MHz. 2:1 at 225 MHz.

**Insertion Loss** — <1 dB at 100 MHz.

**Channel Delay Matching** — Any Group of 4: 50 ps. Any Group of 8: 110 ps. Any Group of 16: 310 ps.

**Type of Relays** — 16 Form A, EAC 05Y21A1 40 BAB, or equivalent. 4 Form "C", TO-5, Teledyne 712-6, or equivalent. Pull In Time: 3 ms. Release Time: 3 ms. Breakdown Voltage: 350 V (dc + peak ac). Series Path Resistance (End of Life): 0.5 Ω.

**Peak Carry Voltage** — Unterminated: 40 V maximum. 50 Ω Terminated: 12.5 V maximum.

**Peak Contact Current** — 0.25 A maximum.

**Peak Switching Voltages** — Unterminated: 15 V maximum. 50 Ω Terminated: 3.73 V maximum.

**Peak Switching Current** — 0.01 A maximum.

## ORDERING INFORMATION

**SI 5010** Scanner **$2,275**

**Includes:** Instruction manual (070-3721-00); instrument interface guide (070-4615-00); reference guide (070-3881-00).

**Utility Software**
For TM 5000/4041 Order 062-6958-01 **$150**

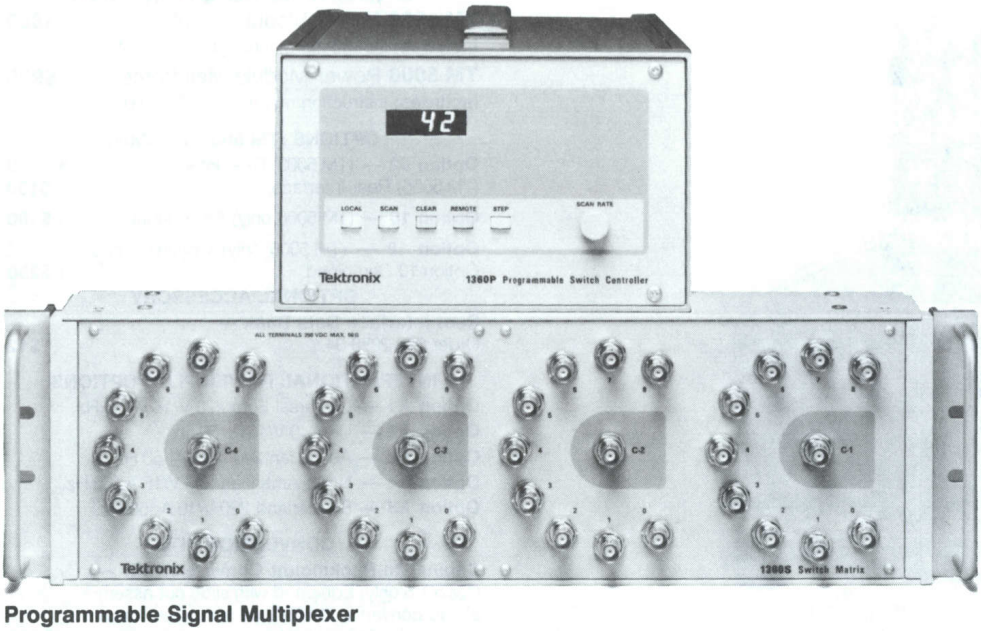
See page 297 for description and ordering information.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

1360P/1360S




**Programmable Signal Multiplexer**

# 1360P/1360S

GPIB IEEE-488 The 1360P/1360S comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats.*

**Signal Bandwidth to 300 MHz**

**50 Ω Environment**

**Selected Pole Readout**

**Flexible Switch Configuration**

**Rackmount or Benchtop**

The 1360P/1360S Programmable Signal Multiplexer is a microprocessor-based, GPIB-compatible system instrument which is used to multiplex electrical signals. The 1360P/1360S system includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix. The 1360P/1360S is not part of the TM 5000 Family and thus does not require a TM 5000 mainframe for operation.

The 1360P Programmable Switch Controller is controlled via the GPIB and provides all the signals required for control of up to four 1360S Switch units. The 1360P is housed in an 8.5-inch wide (half-rackwidth) rackmount chassis, with right or left slider assemblies for rackmounting.

The 1360S Switch Matrix contains four 9-to-1 switches which can be cascaded to provide two 17-to-1 switches; a 25-to-1 switch and a 9-to-1 switch; or a 33-to-1 switch. Up to four 1360S Switch units can be controlled by one 1360P Controller unit to provide up to 129-to-1 multiplexing. In the 9-to-1 configuration, the 1360S has a signal bandwidth of 250 MHz; make/break time in all configurations is <1 ms. The switches in the 1360S can also be ganged together to provide simultaneous and synchronized multiplexing of several groups of signals.

The 1360S is housed in a 5.75-inch high, 19-inch wide rackmount chassis 3-inches deep.

## CHARACTERISTICS

**Bandwidth (3 dB—Through One Switch Only)** — Dc to 300 MHz.

**Maximum Input Voltage** — 250 V dc + peak ac (not to exceed 10 VA).

**Maximum Carry Current** — 250 mA (not to exceed 10 VA).

**Vswr (Through One Switch Only)** — 5.0 at 450 MHz; 3.9 at 400 MHz; 1.9 at 250 Hz; 1.2 at 100 MHz.

**Characteristic Impedance** — 50 Ω ±1 Ω.

**Scan Rate Variability** — >10 s to <3 ms.

**Make/Break Time** — ≤1 ms.

## ORDERING INFORMATION

**1360P** Switch Controller **$2,695**
**Includes:** Instruction manual (070-3476-00).

**1360S** Switch Matrix **$1,695**
**Includes:** Same as above.

# TM 5003/TM 5006

**Power Module Mainframes**

GPIB IEEE-488 The TM 5003 and TM 5006 comply with IEEE Standard 488-1978

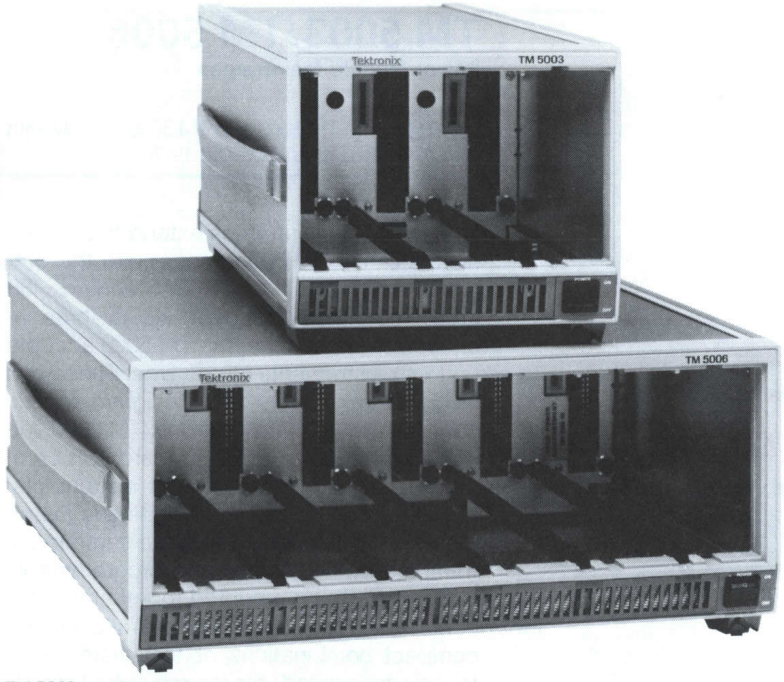
The TM 5000 mainframes extend the convenience of the TM 500 concept into the programmable instrument/IEEE Standard 488 area. The TM 5003 accepts up to three instruments at one time; the TM 5006 accepts up to six instruments at one time. These two TM 5000 mainframes were designed specifically for use with the Tektronix TM 5000 line of programmable, IEEE Standard 488 compatible test and measurement instruments, but all of the TM 500 manual plug-in instruments will also operate in these same mainframes allowing manual and programmable instruments to be mounted together in adjacent slots. This capability permits unique compact combinations of test instruments to be assembled for specific test applications.

Any of the mainframes may be operated with less than a full complement of plug-in instruments installed. TM 5000 instruments cannot be operated in TM 500 mainframes.

**Benchtop or Portability**

The two benchtop mainframes are the TM 5003 and the TM 5006. The TM 5003 is the most compact, accommodating three single-wide plug-ins. The TM 5006 includes a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. Both the TM 5003 and TM 5006 incorporate a quiet fan for optimum cooling; have feet, tilt-bails, handles, and front-panel power switches. Both operate from 110 V ac or 220 V ac.

All benchtop models have carry handles for portable applications.




*TM 5003 and TM 5006 mainframes shown above.*

## Rackmount

The TM 5006 Option 10 is electrically identical to the standard TM 5006 and features a slide assembly and handles, plus a higher-power fan than the bench version to accommodate the higher ambient temperatures often found in enclosed racks and consoles. Kits are available to rackmount a TM 5003 with a 4041 System Controller.

## Rear Interface Capability

Most TM 5000 plug-in modules contain a duplication of the front-panel input and output connections in the back. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. These signals are available at the rear edge-card connector of each plug-in. Any module can be internally connected through the mainframe and also can be externally interfaced out the back panel. Using Option 02 for either mainframe provides the rear interfacing capability.

## Economy

TM 5000 mainframes represent a most economical approach in test and measurement instrumentation. Relatively fixed packaging costs for frames, covers, primary power circuits, unregulated secondary power circuits, and other items are a significant portion of the cost of a typical instrument. Since these fixed costs associated with packaging are shared by many functional instruments in the TM 5000 line, the cost-per-function may be lower than comparable, one or two-function monolithic instruments. Because of its modularity, expandability, and versatility, the modular concept represented by TM 5000 may provide the lowest cost-per-test/measurement when you are considering multifunction usage.

Reduced cabling costs made possible by the rear-interface capability, the requirement for fewer GPIB cables for an equal number of instruments in the TM 5000 line; and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

# CHARACTERISTICS

## POWER REQUIREMENTS

All of the mainframes have manually selectable taps on the power transformer which permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%.

**Power Line Frequency Range** — 48 Hz to 66 Hz.

**Maximum Power Consumption** — Shown in Mainframes Dimensions and Weights chart.

## PHYSICAL CHARACTERISTICS MAINFRAMES (WITHOUT PLUG-INS)

| | TM 5003 | | TM 5006 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 230 | 9.0 | 445 | 17.5 |
| Height | 194 | 7.6 | 194 | 7.6 |
| Depth | 488 | 19.2 | 488 | 19.2 |
| **Weights ≈** | **kg** | **lb** | **kg** | **lb** |
| Net | 8.6 | 19.0 | 14.5 | 32.0 |
| Shipping | 12.0 | 26.5 | 20.9 | 46.0 |
| Maximum Power Consumption*[1] | 300 VA | | 650 VA | |

*[1] *Actual power consumption depends on plug-in selection and operating modes.*

## ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude Range** — Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea Level to 15 000 m (50,000 ft).

# ORDERING INFORMATION

**TM 5003** Power Module Mainframe **$850**
**Includes:** Instruction manual (070-2955-00).

**TM 5006** Power Module Mainframe **$995**
**Includes:** Instruction manual (070-2950-00).

### OPTIONS (TM 5003/TM 5006)

**Option 02** — (TM 5003) Rear Interface. **+$100**
(TM 5006) Rear Interface. **+$190**

**Option 10** — (TM 5006 only) Rackmount. **+$100**

**Option 12** — (TM 5006 only) Option 02 and Option 10 Combined. **+$290**

### OPTIONAL ACCESSORY

**Rear Interface Data Book** —
Order 070-2088-04. **$12**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

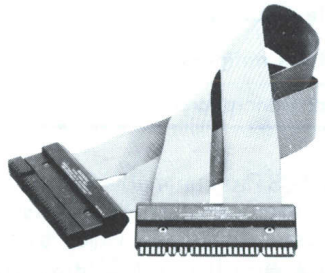
### CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit** — (TM 5006 only) Equipped with slide out assembly, to convert a TM 5006 to rackmount capability. Order 040-0982-01 **$160**

**Rackmount-to-Cabinet Conversion Kit** — (TM 5006 only) Equipped to convert a TM 5006 with rackmount capability to cabinet style. Order 040-0983-00 **$90**

**Cabinet-to-Rackmount Conversion Kit** — (TM 5003 only) Equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003. Order 040-0984-01 **$190**

### FLEXIBLE PLUG-IN EXTENDER CABLE



Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear interface board connection extender, cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

**GPIB Extender Cable** for TM 5000 mainframes. Order 067-0996-00 **$110**

**Extender Cable** for TM 500 mainframes. Order 067-0645-02 **$145**

### GPIB INTERCONNECTING CABLES

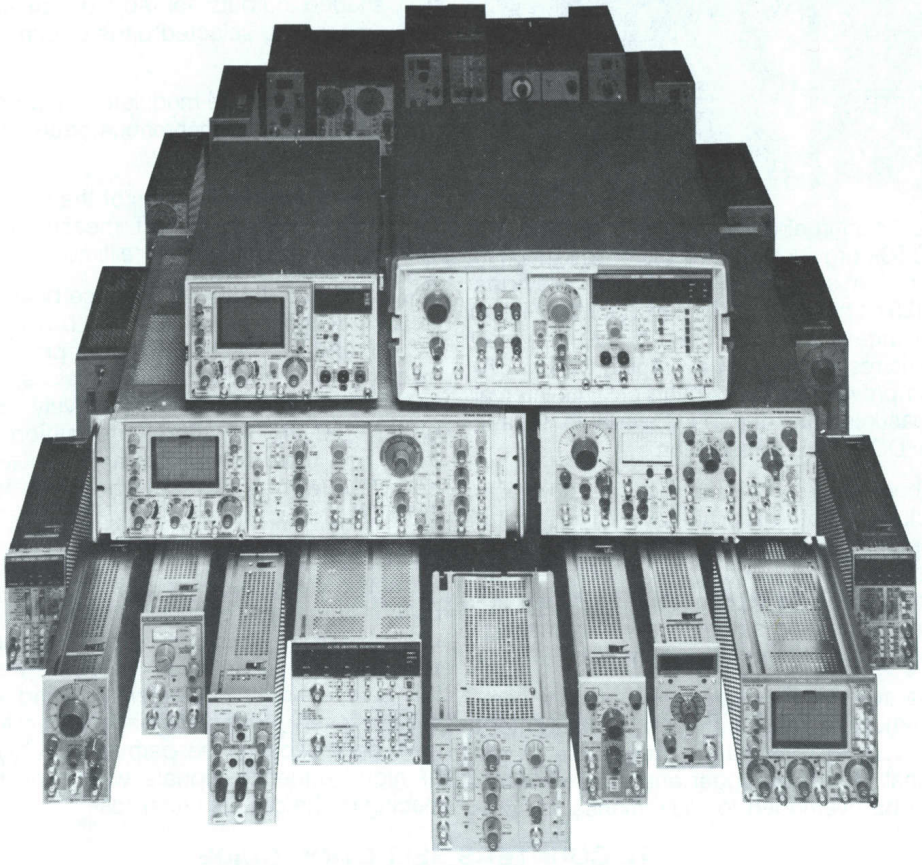
**GPIB Cable** — 0.5 m. Order 012-1015-00 **$65**
**GPIB Cable** — 2 m. Order 012-0630-01 **$75**
**GPIB Cable** — 2 m, Double Shielded. Order 012-0630-03 **$90**

**For additional accessories, see pages 390-392.**



**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

# TM 500 MODULAR TEST AND MEASUREMENT INSTRUMENTS



## CONTENTS


Digital Counters ..... 358
Digital Multimeters ..... 363
Pulse Generators ..... 367
Function Generators ..... 370
Power Supplies ..... 375
Audio Products ..... 377
Signal Conditioners ..... 379
Oscilloscopes ..... 381
Oscilloscope Calibration Instruments ..... 385
TM 500 Mainframes ..... 389
TM 500 Accessories ..... 390


**Manual Instruments that Perform in Hundreds of Combinations**

Configurability is the watchword for TM 500 instruments and mainframes. For a range of test and measurement needs, choose from almost forty ready-to-go, compact plug-ins to create multifunction packages for a wide diversity of applications, or to solve one unique application problem.

TM 500 Instruments include digital counters, pulse generators, function generators, amplifiers, signal processors, audio oscillators, a distortion analyzer, ramp generators, calibration instruments, power supplies, oscilloscopes, digital delay, and a digital latch. Plus three different blank plug-in kits for customizing special functions.

Combine your instruments with the mainframe that meets your environment. There's a travel mainframe for service work and field testing; a rackmount model for production and test; or standard mainframes, compact and convenient for bench or desk, that accept one to six instruments. Rollabout carts are available for lab configurations with Tek oscilloscopes.

All TM 500 instruments and mainframes are electrically and mechanically compatible. So, through interfacing, you can configure an instrument system more powerful than the sum of its parts: an audio lab with distortion analyzer and storage scope, for example.

All of the TM 500 manual instruments may be used in TM 5000 mainframes side-by-side with the TM 5000 GPIB programmable instruments for cost effective solutions to system application where not all functions or measurements need to be programmed. Cost efficiency is as important a part of the TM 500 concept as solving applications problems. You add on performance capabilities when you need them. And when you do add them, you can still use the same mainframe and power supply you started with.

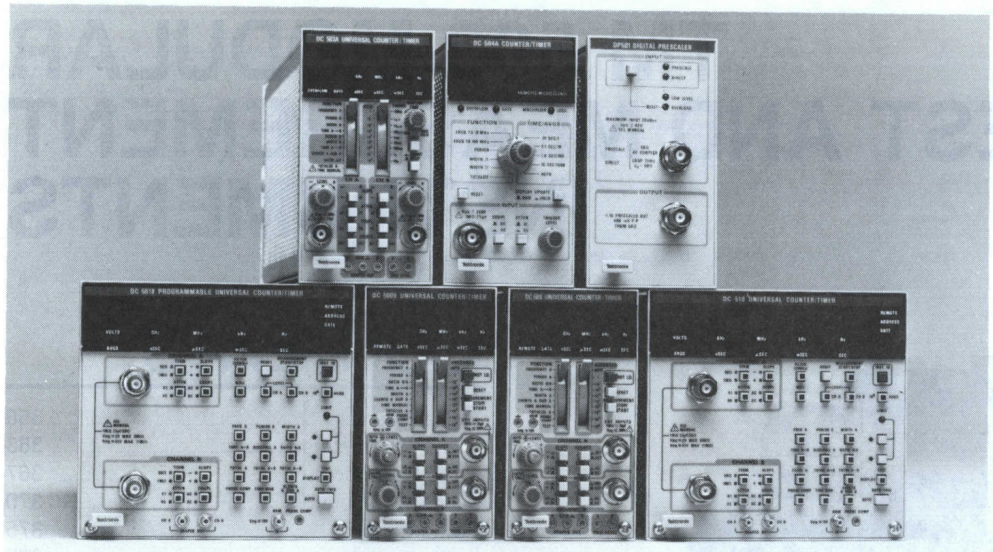
**Application and Construction Notes**

The TM 500 instrument line is supported by an on-going program to communicate up-to-date technical information.

Application Notes outline the steps necessary to solve complex problems, or achieve optimal performance and versatility from your TM 500 instruments. Subjects include integration through v to f conversion, generating delayed pulses, and transducer measurements.

Construction Notes provide information necessary to build custom circuits using a blank plug-in kit and standard components. These notes are developed from the actual construction of more common special circuits and include parts lists, schematics and other construction details. Some of the available TM 500 blank plug-in construction notes include: power supply circuits, thermal true RMS converter, and analog multipliers.

*TM NOTES* is a quarterly newsletter designed to keep TM 500 and TM 5000 users up to date on new products and new applications of existing products.



## A Counter for Every Purpose

The TM 500 Family of digital counters provides a selection of four counters, each with its own performance and price niche, plus a prescaler which adds 1.3 GHz frequency measurement capability to the line.

The 350 MHz DC 510 and the 135 MHz DC 509 Universal Counter/Timers feature reciprocal frequency measurements and an especially wide range of other measurement functions; plus autotrigger, autoaveraging, arming, probe compensation, and more. And IEEE Standard 488 compatibility can be added as a field modification.

For versatility in counting, the DC 503A 125 MHz Universal Counter/Timer features eight measurement functions, including period, width, and time-interval averaging. Both input channels have the full 0 MHz to 125 MHz frequency range, 20 mV RMS sensitivity, and separate controls for input coupling, attenuation, trigger level, and trigger slope. The 10 MHz clock provides 100 ns resolution of single-shot time-interval measurements, and 10 ps resolution with averaging.

The 100 MHz DC 504A features autorange, period and width averaging, and a 100X resolution multiplier to provide high resolution of low frequency signals.

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to all of the above counters except the DC 504A.

## Microprocessor-Based High Performance

Both the DC 510 and DC 509 are microprocessor-based, and contain features available only in high performance, microprocessor-based instruments. Both use a powerful dual-register architecture to obtain high-resolution counting of low frequency signals. The DC 510 provides nine digits of resolution in about a third of a second; the DC 509 provides eight digits of resolution in about a second. The DC 510 provides 3.125 ns single-shot resolution for time-interval measurements. The DC 509 provides 10 ns resolution. With averaging the DC 510 can provide 1 ps resolution on time-interval measurements (the best available today); the DC 509, 5 ps resolution.

Other features available in both instruments include autotrigger, autoaveraging, probe compensation, and diagnostic self-test. At the push of a button, the autotrigger feature senses the top and bottom of the applied signal and automatically sets the trigger point midway between the two.

Autoaveraging provides the optimum combination of resolution and measurement time, regardless of the frequency of the signal. Both autotrigger and autoaveraging can be overridden to allow manual (or programmable, in the case of the GPIB versions) control of averaging, measurement time, and triggering levels.

The probe compensation feature on both instruments allows the user to quickly and accurately compensate a high-impedance probe to the instrument input impedance directly. Improperly compensated probes are a common source of timing errors when using counters without this feature.

Both instruments include an arming input and shaped outputs for added versatility when measuring selected parts of complex waveforms.

Both feature a phase-modulated time base to eliminate clock synchronous errors in all time averaging modes.

In addition to all the features of the DC 509, the DC 510 permits direct measurement and display of risetime and falltime.

The addition of the GPIB interface board (a field modification) converts both the DC 510 and DC 509 into their fully programmable, fully GPIB-compatible versions, the DC 5010 and DC 5009, respectively. See pages 340-343 for more information on these and other fully-programmable, GPIB-compatible products in the Tektronix TM 5000 product line.

## Accessory Probe

An optional accessory probe, the Tektronix P6125, has been especially designed for use with digital counters. The 5X attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. Low input capacitance permits acquisition of high-frequency signals with minimum loading of the circuits under test.

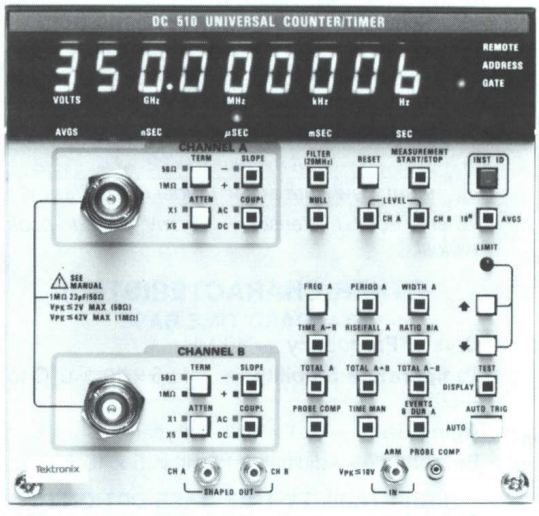
## DIGITAL COUNTERS SELECTION GUIDE

| APPLICATION/FEATURE | DC 510/DC 5010 | DC 509/DC 5009 | DC 503A | DC 504A |
|---|---|---|---|---|
| Frequency Range | 350 MHz | 135 MHz | 125 MHz | 100 MHz |
| Number of Digits | 9 | 8 | 8 | 6 |
| Ratio Architecture | ✓ | ✓ | | |
| Period Averaging | ✓ | ✓ | ✓ | ✓ |
| Width Averaging (Single Input) | ✓ | ✓ | ✓ | ✓ |
| Time Interval Averaging | ✓ | ✓ | ✓ | |
| Autotrigger | ✓ | ✓ | | |
| Gated Events Averaging | B during A | B during A | A during B | |
| Ratio Averaging | ✓ | ✓ | ✓ | |
| Other | High stability time base, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation, time manual, totalize. | High stability time base, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation, time manual, totalize. | High stability time base trigger level and shaped outputs, time manual, totalize. | Autorange, 100X resolution multiplier |
| IEEE Standard 488 | ✓*1 | ✓*1 | | |
| Mainframe Compatibility | DC 510 TM 500/TM 5000 DC 5010 TM 5000 only | DC 509 TM 500/TM 5000 DC 5009 TM 5000 only | TM 500/ TM 5000 | TM 500/ TM 5000 |
| Page | 359/340 | 359/342 | 359 | 362 |
| Prices Begin At | $3,985/$4,485 | $2,150/$2,650 | $1,295 | $950 |

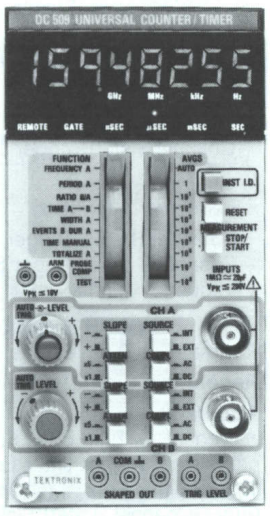
*1 *Included with DC 5010/DC 5009. Conversion kit required to add IEEE Standard 488 capability to the DC 510/DC 509.*

**For compatible accessories — see page 408.**

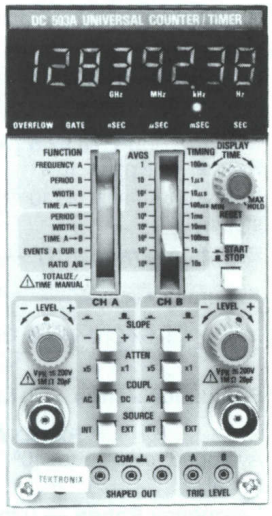
**DC 510**




**DC 509**




**DC 503A**




**Universal Counter/Timers**

# DC 510/DC 509

**350 MHz Both A and B Channels (DC 510)**

**135 MHz Both A and B Channels (DC 509)**

**3.125 ns Single-Shot Resolution (DC 510)**

**10 ns Single-Shot Resolution (DC 509)**

**9-Digit Display (DC 510)**

**8-Digit Display (DC 509)**

**1 ps Resolution, with Averaging (DC 510)**

**5 ps Resolution, with Averaging (DC 509)**

With the exception of programmability and IEEE Standard 488 compatibility, the characteristics and specifications of the DC 510/DC 509 Universal Counter/Timers are identical to those of the DC 5010/DC 5009 Universal Counter/Timers. The detailed specifications of the DC 5010/DC 5009 Universal Counter/Timers are given on pages 340-343.

A conversion kit is available to owners of DC 510's and DC 509's who desire IEEE Standard 488 capabilities. The field modification kit easily converts a DC 510 to a DC 5010 or a DC 509 to a DC 5009.

## ORDERING INFORMATION

**DC 510** Universal Counter/Timer **$3,985**
**Includes:** Instruction manual (070-3552-01).

**DC 509** Universal Counter/Timer **$2,150**
**Includes:** Instruction manual (070-3464-00).

**Option 01** — High Stability Time Base. **+$325**

**CONVERSION KITS (DC 510/DC 509)**

**High Stability Time Base** —
Order 040-0966-00 **$250**

**IEEE Standard 488 Capability** —
(DC 510) Order 040-1023-04 **$290**
(DC 509) Order 040-0957-04 **$290**

**RECOMMENDED PROBE**

**P6125 5X** — Passive Probe.
Order 010-6125-01 **$70**

# DC 503A

**125 MHz Both A and B Channels**

**10 ps Resolution in Time Interval Average with $10^8$ Averages**

**Measurement Functions Include:**

**Frequency; Period and Period Average; Width and Width Average; Time A→B and Time A→B Average; Events A During B and Events A During B Average; Totalize; Time Manual; Ratio A/B Average**

**40 MHz Rep Rate in Time Interval Average**

**Simplified Width Measurement**

**Trigger Level Outputs for Accurate Trigger Setting**

**Shaped Outputs for Ease of Triggering**

**Designed for True Probe Compatibility**

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125 MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A and an averaging feature allows averaging of 1 to $10^8$ occurrences of the signal of interest. Signals to be counted or timed can be applied to channels A and B via front panel BNC connectors, or through rear interface connections. The DC 503A features an easy access front panel and an LSI based design for increased instrument reliability.

The DC 503A can be equipped with an optional temperature controlled 10 MHz crystal oscillator (Option 01) to obtain a highly stable and precise internal time base. Both the optional oscillator and the standard 10 MHz crystal oscillator provide 100 ns resolution of single-shot time intervals.

## CHARACTERISTICS

**Display** — Eight digit LED; indicators for units, gate open, and overflow.

**Display Time** — ≈0.2 s to 5 s and hold.

### CHANNEL A AND B INPUT

**Frequency Range** — 0 MHz to 125 MHz, dc coupled. 10 Hz to 125 MHz, ac coupled.

**Sensitivity** — 20 mV RMS sinewave to 100 MHz. 60 mV p-p at minimum pulse width (of 5 ns to 100 MHz). 35 mV RMS sinewave to 125 MHz. 100 mV p-p (minimum pulse width of 4 ns to 125 MHz).

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 MΩ paralleled by ≈27 pF.

**Dynamic Range** — V p-p ⩽3 V x attenuation. V peak ⩽3.5 x attenuation.

**Trigger Level Range** — Adjustable ±3.5 V x attenuation.

**Trigger Level Accuracy** — ±0.5% of reading for a dc input V, ±20 mV x attenuator.

**Independent Controls** — Slope +/−, Attenuation 1X/5X, Coupled ac/dc, Source Internal/External.

**Maximum Input Voltage**
1X: 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 125 MHz.
5X: 200 V peak; 400 V p-p from dc to 5 MHz, derate to 20 V p-p from 100 MHz to 125 MHz.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms. ⩾200 mV p-p from 50 Ω.

### FREQUENCY A

**Range** — 0 MHz to 125 MHz.

**Resolution** — 0.1 Hz to 10 MHz in decade steps.

**Accuracy** — ±1 count ± Time Base Error x Frequency A.

### PERIOD B (SINGLE SHOT)

**Range** — 100 ns to $10^9$ s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy** — ±1 count ± Time Base Error x Period B ±1.4 x Channel B Trigger Jitter Error.

**Frequency Range** — 0 MHz to 125 MHz.

### PERIOD B (Average)

**Range** — 8 ns to 10 s.

**Resolution** — 1 fs ($10^{-15}$) to 100 ns in decade steps.

**Events Averaged (N)** — 1 to $10^8$.

**Accuracy** — $\pm\frac{100\text{ ns}}{N}$ ± Time Base Error x Period B $\pm\frac{1.4 \times \text{Channel B Trigger Jitter Error}}{N}$

**Frequency Range** — 0 MHz to 125 MHz.

### RATIO A/B

Averaged over 1 to $10^8$ cycles of Channel B signal.

**Frequency Range** — 0 to 125 MHz (both Channel A and Channel B).

**Accuracy** — $\pm\frac{\text{Frequency B}}{\text{Frequency A} \times N}$

$\pm\frac{1.4 \times \text{Channel B Trig Jitter Error} \times \text{Frequency A}}{N}$

$\pm\frac{\text{Frequency A}}{0.3 \times 10^8}$

### TIME A→B (SINGLE SHOT)

**Range** — 100 ns to $10^9$ s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy** —
±1 count ± Time Base Error x Time A→B
±Channel A Trigger Jitter Error
±Channel B Trigger Jitter Error
±(Channel B stop Trigger Slew Error
−Channel A start Trigger Slew Error) ±4 ns.

### TIME A→B (AVERAGE)

**Range** — 12.5 ns to 10 s.

**Minimum Dead Time** — 12.5 ns (stop-to-start).

**Resolution** — $\frac{100\text{ ns}}{\sqrt{N}}$

**Events Averaged (N)** — 1 to $10^8$ in decade steps.

**Accuracy** —

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ± Time Base Error x Time A→B

$\pm\frac{\text{Channel A Trigger Jitter Error}}{\sqrt{N}}$

$\pm\frac{\text{Channel B Trigger Jitter Error}}{\sqrt{N}}$

+(Channel B stop Trigger Slew Error
−Channel A start Trigger Slew Error) ±4 ns

### EVENTS A DURING B (AVERAGE)

**Maximum A Frequency** — 125 MHz.

**Minimum B Pulse Width** — 5 ns.

**Events Averaged (N)** — 1 to $10^8$ in decade steps.

**Accuracy** —

$\pm\frac{\text{Period A}}{\text{Width B} \times \sqrt{N}}$ x Events A during B

$\pm\frac{\text{Channel B start Trigger Jitter Error}}{\sqrt{N}}$

x Frequency A (in MHz)

$\pm\frac{\text{Channel B stop Trigger Jitter Error}}{\sqrt{N}}$

x Frequency A (in MHz)

+(Channel B stop Trigger Slew Error
−Channel B start Trigger Slew Error)
x Frequency A (in MHz)

### WIDTH B (SINGLE SHOT)

**Range** — 100 ns to $10^9$ s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy** —
±1 count ± Time Base Error x Width B ±Channel B start Trigger Jitter Error ±Channel B stop Trigger Jitter Error +(Channel B stop Slew Rate Error—Channel B start Slew Rate Error).

### WIDTH B (AVERAGE)

**Range** — 5 ns to 10 s.

**Resolution** — $\frac{100\text{ ns}}{\sqrt{N}}$

**Events Averaged (N)** — 1 to $10^8$ in decade steps.

**Accuracy** —

$\pm\frac{100\text{ ns}}{\sqrt{N}}$ ± Time Base Error x width B

$\pm\frac{\text{Channel B start Trigger Jitter Error}}{\sqrt{N}}$

$\pm\frac{\text{Channel B stop Trigger Jitter Error}}{\sqrt{N}}$

+(Channel B stop Slew Rate Error −Channel B start Slew Rate Error)

**Frequency Range** — 0 MHz to 100 MHz.

### TIME MANUAL

Electronic stopwatch, accumulates and displays time between activation of front panel start/stop button or rear interface signal line. Clock rates selectable from 100 ns to 10 s in decade steps. Range 100 ns to $10^9$ s.

### TOTALIZE A

1 count to 99,999,999 counts at maximum rate of 125 MHz. Start, stop and reset controlled by front panel pushbuttons or rear interface signal lines.

### RESOLUTION AND ACCURACY DEFINITIONS

Time Base Error is the sum of all errors specified for the time base used.

N is the number of periods averaged in Period B (AVGS) mode, the number of intervals averaged in the Time A→B (AVGS) mode, the number of widths of B averaged in Width B (AVGS) and Events A During B modes, and the number of periods of B in the Ratio A/B mode.

**Trigger Jitter Error (in μs)** =

$$\frac{\sqrt{(en_1)^2 + (en_2)^2}\ (V)}{\text{Input Slew Rate at Trigger Point (V/μs)}}$$

*Where: $en_1$ = 100 μV RMS typical internal noise.*
*$en_2$ = RMS noise of signal input at trigger point for a 125 MHz bandwidth.*

**Trigger Slew Rate Error (in μs)** =

$$\frac{\textit{Input hysterisis (V)/2}}{\textit{Input Slew Rate at set Trigger Point V/μs}}$$

*Where: Input hysterisis = 20 mV peak-to-peak typical.*

## OTHER CHARACTERISTICS

### STANDARD TIME BASE

**Crystal Frequency** — 10 MHz.

**Temperature Stability** — < ±5 x $10^{-6}$, 0°C to +50°C.

**Aging Rate** — <1 x $10^{-6}$ per year.

**Setability** — Adjustable to within 5 x $10^{-8}$.

### HIGH STABILITY TIME BASE OPTION 01

**Crystal Frequency** — 10 MHz.

**Temperature Stability** — < ±2 x $10^{-7}$ after warm-up, 0°C to +50°C.

**Warmup Time** — Within 2 x $10^{-7}$ of final frequency in <10 minutes when cold started at 25°C.

**Aging Rate** — 1 x $10^{-8}$/day at time of shipment, 4 x $10^{-8}$/week after 30 days of continuous operation, 1 x $10^{-6}$/year after 60 days of continuous operation.

**Setability** — Adjustable to within 2 x $10^{-8}$.

### REAR INTERFACE

**Inputs** — Direct count input to 50 MHz, (50 Ω impedance, resistor may be removed for 1 MΩ impedance, remote start/stop, reset; external time base.

**Outputs** — BCD serial-by-digit, decimal point, overflow, scan clock; trigger level; time base reference.

## ORDERING INFORMATION

**DC 503A** Universal Counter/Timer **$1,295**
**Includes:** Instruction manual (070-2971-00).

**Option 01** — High Stability Time Base. **+$325**

**CONVERSION KITS**

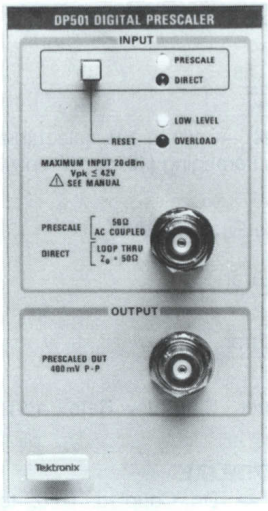
**High Stability Time Base** —
Order 040-0966-00 **$250**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

**DP 501**




**Digital Prescaler**

# DP 501

**Extends Frequency Measurement Capability to 1.3 GHz**

**Compatible with Most TM 500 and TM 5000 Counters**

**AGC**

**Low Level Indicator**

The DP 501 Digital Prescaler adds 1.3 GHz frequency counting capability to the Tektronix DC 503A, DC 509, DC 5009, DC 510, and DC 5010 Universal Counter/Timers.

The DP 501 is placed in the signal line between the signal source and the counter's input connector such that the signal to be measured passes through the DP 501. Two operating modes are available, Prescale and Direct. In the Prescale mode, the DP 501 divides the input signal by 16 and causes the associated counter's display to be multiplied by 16, so that the counter will display the correct frequency. In the Direct mode, the signal is simply looped through the DP 501 and applied directly to the counter's input; the counter's display is not affected. This loop-through capability eliminates the need for external switching when input signal frequencies occur in both the Prescale and Direct frequency ranges.

The prescaling function can be activated in either of two ways: manually, with a front-panel push button; or, when used with the GPIB programmable DC 5009 or DC 5010, by a Prescale command to the counter. Thus, the DP 501 adds programmable frequency measurements to 1.3 GHz to the Tektronix TM 5000 Family of GPIB programmable instruments.

Input sensitivity in the Prescale mode is 20 mV RMS to 1 GHz and 30 mV RMS to 1.3 GHz. A Low-Level indicator alerts the user if the input signal amplitude is too low for error-free counting. An automatic gain control circuit provides optimum immunity to signal noise in the Prescale mode.

The DP 501 and DC 509 or DC 510 can be used with the Tektronix 7L14 Spectrum Analyzer and TR 502 Tracking Generator to provide counter accuracy measurements of swept-frequency signals from 100 kHz to 1.3 GHz.

## CHARACTERISTICS

**Prescale Mode —** Input: Frequency range is ≤100 MHz to ≥1.3 GHz. Sensitivity: 100 MHz to 1 GHz is ≤20 mV RMS (−21 dBm). 1 GHz to 1.3 GHz is ≤30 mV RMS (−17 dBm). Impedance: 50 Ω, ac coupled; vswr ≤2.2:1. Output: Amplitude into 50 Ω is ≥200 mV, p-p. Unterminated is 2X terminated value.

**Direct Mode —** Input: Connected directly to output. Frequency Range: 0 MHz to >350 MHz. Impedance: Loop through characteristic impedance is 50 Ω; nonterminated capacitance ≈20 pF (no connection to output). Output: Connected directly to input. <1 dB insertion loss up to 350 MHz. Powers up in direct mode.

**Overload Protection —** Prescale: Input disconnects when input signal exceeds +20 dBm ±5 dBm for a period of ≈0.5 s or more.

**Damage Level —** Prescale: Input may be damaged if signal level exceeds +25 dBm. Direct: 42 V peak maximum. Maximum current is 250 mA.

**Input Attenuation —** Automatic: Up to 40 dB range.

**Low Level Indicator —** Lights when input signal is below that required for error-free counting.

**Tracking Generator Compatibility —** Outputs will drive two standard TTL loads. Inputs represent two standard TTL loads. Requires arming input to associated counter.

## ORDERING INFORMATION

**DP 501** Digital Prescaler **$575**

**Includes:** Instruction manual. (070-4332-00).

# P6125 Counter Probe

The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

## CHARACTERISTICS

**Attenuation —** 5X.

**Input Resistance —** 5 MΩ input.

**Capacitance —** ≈20 pF.

**Bandwidth —** Dc to 200 MHz.

**Voltage Rating —** 250 V (dc + peak ac) derated to 35 V at 100 MHz.

**Cable Length —** 1.5 meters.

## ORDERING INFORMATION

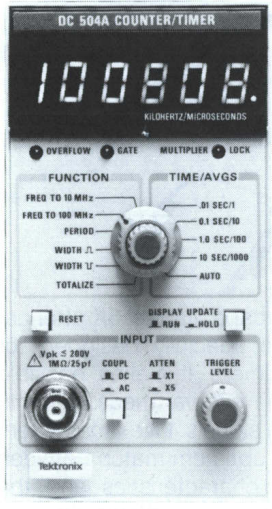
**P6125** Counter Probe, 5X, 1.5 m.
Order 010-6125-01 **$70**

**Includes:** 8 cm ground lead (175-0263-01); accessory pouch (016-0521-00); two miniature alligator clips (344-0046-00); IC tip tester*1, two 13 cm ground lead probe*2 tips (175-0124-01); retractable hook tip (013-0107-03); probe holder (352-0351-00); insulating sleeve (166-0404-01); instruction sheet (070-3617-00).

*1 *Available in packages of 10 (015-0201-04) or 100 (015-0201-05).*

*2 *Available in packages of 10 only (206-0191-03).*

**DC 504A**




**Counter/Timer**

# DC 504A

**Dc to 100 MHz**

**Period and Period Averaging**

**Width and Width Averaging**

**Autoranging**

**100X Resolution Multiplier**

The easy-to-use DC 504A Counter/Timer measures frequency from dc to 100 MHz, with an internal prescaler being used for frequencies above 10 MHz. Both direct and prescaled counting are done through the same input connector; no need to change connectors when changing frequency range. Autoranging permits virtual hands-off operation for most measurements. The 100X resolution multiplier automatically provides 0.01 Hz resolution in one second—or 0.001 Hz resolution in ten seconds—on signals from 10 Hz to 25 kHz.

The DC 504A features period and width averaging of up to 1000 events. Selectable dc coupling of the input eliminates the potential errors associated with making width measurements on signals of varying duty cycle with counters that are only ac coupled. Input trigger sensitivity is 30 mV RMS across the entire 100 MHz frequency range. The triggering level range of ±2 volts and the selectable 5X attenuator provides a triggering range of up to ±10 volts.

The totalize mode permits totalizing up to 999,999 events—and beyond, with overflow—with a Display Update-Run/Hold control to hold the display while the internal counter continues to advance.

## CHARACTERISTICS

**Display** — Six-digit LED readout with automatic decimal point positioning and leading zero suppression. LED annunciators indicate gate open, resolution multiplier lock, and display overflow.

### INPUT

**Frequency Range** — Front Panel: Dc Coupled is 1 MHz to 100 MHz. Ac Coupled is 10 Hz to 100 MHz. Rear Interface: Dc Coupled is 0 MHz to 50 MHz. Ac Coupled is 10 Hz to 50 MHz.

**Sensitivity** — 1X Attenuation: 30 mV RMS sinewave to 100 MHz; 85 mV p-p (at a minimum pulse width of 5 ns). 5X attenuation accuracy is within 2% at dc.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — Front Panel, 1X, 5X: 1 MΩ, paralleled by ≈25 pF. Rear Interface, 1X, 5X: 50 Ω ±10% at dc.

**Dynamic Range** — 1X: ±2.0 V peak, 4 V p-p. 5X: ±10 V peak, 20 V p-p.

**Trigger Level Range** — ±2.0 V x attenuation minimum.

**Maximum Input Voltage** — Front Panel: 1X is 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 100 MHz. 5X is 200 V peak; 400 V p-p from dc to 50 MHz, derate to 20 V p-p at 100 MHz. Rear Interface: ≤4 V peak.

### FREQUENCY TO 10 MHz

**Range** — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz.

**Resolution** — Multiplier Off: 100 Hz to 0.1 Hz, selectable in decade steps or autoranging (100 Hz to 1 Hz only). Multiplier On: 1 Hz to 0.001 Hz, selectable in decade steps or autoranging (1 Hz to 0.01 Hz only). Lock Range: 10 Hz ≤Frequency ≤25 kHz. Multiplication: 100X. Lock Time: ≤5 s. Resolution multiplier automatically increases resolution by 100 when locked; may be defeated by an internal jumper.

**Accuracy** — ±1 count ±Time Base Error x Frequency. See page 360 for example.

**Gate Time** — 10 ms to 10 s, selectable in decade steps; or autoranging (10 ms to 1 s only).

### FREQUENCY TO 100 MHz

**Range** — Dc Coupled: 0 Hz to 100 MHz. Ac Coupled: 10 Hz to 100 MHz.

**Gate Time (Resolution)** — 10 ms to 10 s (1 kHz to 1 Hz), selectable in decade steps; or autoranging (10 ms to 1 s only).

**Accuracy** — ±1 count ±Time Base Error x Frequency.

**Prescale Factor** — ÷10.

### PERIOD AVG

**Range** — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

**Resolution** — 100 ns to 100 ps, selectable in decade steps; or autoranging (100 ns to 1 ns only).

**Events Averaged (N)** — $10^0$ to $10^3$, selectable in decade steps; or autoranging ($10^0$ to $10^2$ only).

**Accuracy** —

$$\pm\frac{100\text{ ns}}{N} \pm \text{Time Base Error} \times \text{Period} \pm 1.4 \times \left(\frac{\text{Trigger Jitter Error}}{N}\right)$$

### WIDTH AVG

**Range** — Dc Coupled: 0 Hz to 2.5 MHz. Ac Coupled: 10 Hz to 2.5 MHz.

**Resolution** — $\pm\frac{100\text{ ns}}{\sqrt{N}}$

**Events Averaged (N)** — $10^0$ to $10^3$, selectable in decade steps; or autoranging ($10^0$ to $10^2$ only).

**Accuracy** —

$$\pm\frac{100\text{ ns}}{\sqrt{N}} \pm \text{Time Base Error} \times \text{Width}.$$

$$\pm\frac{\text{Start Trigger Jitter Error}}{\sqrt{N}}$$

$$\pm\frac{\text{Stop Trigger Jitter Error}}{\sqrt{N}}$$

+(Stop Slew Rate Error - Start Slew Rate Error) ±10 ns

### TOTALIZE

**Frequency Range** — Dc Coupled: 0 Hz to 10 MHz. Ac Coupled: 10 Hz to 10 MHz. Overflows above 999,999. Display update Run/Hold will hold display while counter continues to advance. Releasing Run/Hold will update display to new value.

### TIME BASE

**Frequency (At Calibration)** — 10 MHz ±1 x $10^{-7}$.

**Temperature Stability** — ±5 x $10^{-6}$ (±5 ppm), 0°C to +50°C.

**Adjustment Resolution** — ±5 x $10^{-8}$.

**Aging Rate** — ≤1 x $10^{-6}$/year (≤1 ppm/year).

### EXTERNAL TIME BASE INPUT

10 MHz. Must drive 1 LSTTL load. $V_{IH}$ = 2.0 V/20 μA $V_{IL}$ = 0.8 V/−400 μA.

### RESOLUTION AND ACCURACY DEFINITIONS

Same as DC 503A except DC 504A has 100 MHz bandwidth and input hysteresis = 30 mV p-p typical.

## ORDERING INFORMATION

**DC 504A** Counter/Timer **$950**

**Includes:** Instruction manual (070-4291-00).

**OPTIONAL COUNTER ACCESSORIES**

**P6101 X1 Probe** — Dc to 34 MHz. Order 010-6101-13 **$67**

**P6106 X10 Probe** — Dc to 300 MHz. Order 010-6106-13 **$140**

**P6201 FET Probe** — Dc to 900 MHz. Order 010-6201-01 **$1,220**

**P6230 Bias/Offset Probe** — Dc to 1.5 GHz. Order 010-6230-01 **$395**

**P6056 50 Ω, X10 Probe** — Dc to 3.5 GHz. Order 010-6056-03 **$185**

**Power Divider** — GR, 50 Ω. Order 017-0082-00 **$375**

**Adaptor** — GR to BNC female. Order 017-0067-00 **$55**

**Adaptor** — GR to BNC male. Order 017-0064-00 **$75**

**Cable Adaptor** — BNC to tipjack (DC 503A, DC 509,DC 5009). Order 175-3765-01 **$28**

**Cable Adapator** — BNC to RF (DC 510, DC 5010). Order 012-0532-00 **$35**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## PRODUCT SUMMARY

The TM 500 Digital Multimeter line consists of two general purpose instruments, the DM 501A and DM 502A. Both provide exceptional versatility in function and range. In addition to the usual ac and dc voltage, resistance, and ac/dc current functions, both meters offer a dB function and a platinum-resistance temperature-measurement function, which provides digital readout of the surface temperature in degree Centigrade.

The DM 501A and DM 502A each measure dc voltage to 1000 V, ac voltage to 500 V, both ac and dc current to 2 A, true RMS voltages, and resistance to 20 MΩ. The most significant differences are increased resolution provided by the extra digit on the DM 501A, increased temperature measurement range of the DM 501A and autoranging on the DM 502A.

TM 500 digital multimeters offer a compact solution to your measurement needs without compromising wide performance range. The DM 501A and DM 502A provide accuracy and flexibility in laboratory bench, field service, and maintenance applications.

## DIGITAL MULTIMETER SELECTION GUIDE

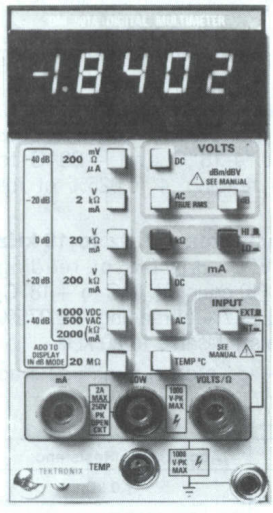
| Application Feature | DM 501A | DM 502A | DM 5010 |
|---|---|---|---|
| Number of Digits | 4½ | 3½ | 3½/4½*1 |
| Dc Volts Ranges | 200 mV to 1000 V | 200 mV to 1000 V | 200 mV to 1000 V |
| Dc Volts Accuracy | ±0.05% | ±0.1% | ±0.015% |
| Dc Volts Best Resolution | 10 μV | 100 μV | 10 μV |
| Ac Volts Ranges | 200 mV to 500 V | 200 mV to 500 V | 200 mV to 700 V |
| Ac Volts Accuracy | ±0.6% | ±0.6% | ±0.2% |
| Ac Volts Best Resolution | 10 μV | 100 μV | 10 μV |
| Ac or Dc Current Ranges | 200 μA to 2 A | 200 μA to 2 A | N/A |
| dB Ranges | +54 dB to −60 dB | +50 dB to −60 dB | Calculated |
| Resistance (HI-LO) Ranges | 200 Ω to 20 MΩ | 200 Ω to 20 MΩ | 200 Ω*2 to 20 MΩ |
| Temperature Range | −62°C to +240°C | −55°C to +200°C | N/A |
| True RMS | ✓ | ✓ | ✓ |
| Autorange | ✓ | | ✓ |
| IEEE Standard 488 | | | ✓*3 |
| Mainframe Compatibility | TM 500 TM 5000 | TM 500 TM 5000 | TM 5000 |
| Page | 363 | 364 | 344 |
| Prices Begin At | $795 | $750 | $2,260 |

*1 *Measurement rate of 3 readings/s at 4.5 digits, and 26 readings/s at 3.5 digits resolution.*

*2 *Low Ω plus diode test.*

*3 *Fully programmable, IEEE Standard 488 compatible.* *See page 344 for complete description.*

**DM 501A**




**Digital Multimeter**

# DM 501A

**0.05% dc Voltage Accuracy**

**7 Functions Including Temperature and dB**

**4½ Digits of Readout Resolution**

**True RMS Capability**

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB and temperature. The DM 501A gives 4½ digits of readout resolution. All with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted waveforms. DB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the Tektronix P6601 platinum film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds.

## CHARACTERISTICS

### DC VOLTS

**Ranges** — 200 mV, 2 V, 20 V, 200 V, and 1000 V.

**Accuracy*1**

**+18°C to +28°C**

| Voltage Ranges | Normal and Fast Conversion Rate |
|---|---|
| 200 mV | ±[0.05% of reading +0.015% of full scale (3 counts)] |
| 2 V to 200 V | ±[0.05% of reading +0.01% of full scale (2 counts)] |
| 1000 V | ±[0.05% of reading +0.02% of full scale (2 counts)] |
| **0°C to +18°C, +28°C to +50°C** | |
| 200 mV to 200 V | ±[0.1% of reading +0.025 of full scale (5 counts)] |
| 1000 V | ±[0.1% of reading ±0.05% of full scale (5 counts)] |

*1 *Valid for six months or 1000 hours, whichever occurs first.*

**Common-Mode Rejection Ratio** — ⩾100 dB at dc. ⩾80 dB at 50 Hz and 80 Hz with 1 kΩ imbalance.

**Normal-Mode Rejection Ratio** — ⩾60 dB at 50 Hz or 60 Hz ±0.2 Hz.

**Maximum Resolution** — 10 μV.

**Step Response Time** — <1 s.

**Input Resistance** — 10 MΩ.

**Maximum Input Voltage** — 1000 V peak.

### TRUE RMS AC VOLTS

**Input Signal** — Must be between 5% and 100% of full scale.

**Ranges** — 200 mV, 2 V, 20 V, 200 V, and 500 V (ac coupled).

**Accuracy*1**

**+18°C to +28°C**

| Voltage Ranges | 20 Hz to 40 Hz | 40 Hz to 10 kHz | 10 kHz to 20 kHz |
|---|---|---|---|
| 200 mV to 200 V | ±[1% of reading +0.05% of full scale (10 counts)] | ±[0.6% of reading +0.05% of full scale (10 counts)] | ±[1% of reading +0.05% of full scale (10 counts)] |
| 500 V | ±[1% of reading +0.2% of full scale (10 counts)] | ±[0.6% of reading +0.2% of full scale (10 counts)] | ±[1% of reading +0.2% of full scale (10 counts)] |

**0°C to +18°C, +28°C to +50°C**

| Voltage Ranges | 20 Hz to 40 Hz | 40 Hz to 10 kHz | 10 kHz to 20 kHz |
|---|---|---|---|
| 200 mV to 200 V | ±[1.3% of reading +0.075% of full scale (15 counts)] | ±[0.8% of reading +0.075% of full scale (15 counts)] | ±[1.3% of reading +0.075% of full scale (15 counts)] |
| 500 V | ±[1.3% of reading +0.3% of full scale (15 counts)] | ±[0.8% of reading +0.3% of full scale (15 counts)] | +[1.3% of reading +0.3% of full scale (15 counts)] |

*1 *Valid for six months or 1000 hours whichever occurs first.*

**Common-Mode Rejection Ratio** — ⩾60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

**Maximum Resolution** — 10 μV.

**Response Time** — <2 s.

**Input Impedance** — 10 MΩ paralleled by 160 pF.

**Maximum Input Voltage** — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

**Crest Factor** — 4 (at full scale).

### dB (TRUE RMS)

**Zero dB Reference** — 1 mW in 600 Ω (0.775 V) (dBm) Internal jumper change for 0 dB reference of 1.0000 V (dBV).

**Accuracy*[1]**

+18°C to +28°C

| 20 Hz | 2 kHz | 10 kHz | 20 kHz |
|---|---|---|---|
| +50 dB to −50 dB | 0 | ±0.5 dB | |
| −50 dB to −60 dB | ±0.5 dB | ±1.5 dB | Typically ±2.5 dB |

*[1] *From 0°C to +18°C +28°C to +50°C, add 0.6 dB to above accuracy specifications.*

**Maximum Resolution** — 0.1 dB.

**Response Time** — <2 s.

**Input Impedance** — 10 MΩ paralleled by <160 pF.

**Maximum Input Voltage** — 500 V RMS, not to exceed 1000 V peak. Equivalent to +54 dBV or +56.2 dBm.

**Crest Factor** — 4 (at full scale).

### RESISTANCE

**Response Time** — <2 s in 200 Ω to 2000 kΩ ranges; <10 s in 20 MΩ range.

**Maximum Input Volts** — 250 V peak.

**Maximum Resolution** — 10 mΩ.

**HI-LO Ohm Operation** — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

**Maximum Open-Circuit Voltage Developed** — <6 V.

**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ.

**Accuracy*[1]**

| Resistance Ranges | Normal and Fast Conversion Rate | |
|---|---|---|
| **+18°C to +28°C** | | |
| 200 Ω | LO Ω | ±[0.15% of reading +0.015% of full scale (3 counts)] |
| 2 kΩ to 2000 kΩ | HI Ω | ±[0.15% of reading +0.015% of full scale (3 counts)] |
| 2 kΩ to 200 kΩ | LO Ω | ±[0.15% of reading +0.015% of full scale (3 counts)] |
| 2000 kΩ | LO Ω | ±[0.3% of reading +0.015% of full scale (3 counts)] |
| 20 MΩ | HI Ω only | ±[0.5% of reading +0.015% of full scale (3 counts)] |
| **0°C to +18°C, +28°C to +50°C** | | |
| 200 Ω | LO Ω | ±[0.3% of reading +0.025% of full scale (5 counts)] |
| 2 kΩ to 2000 kΩ | HI Ω | ±[0.3% of reading +0.025% of full scale (5 count)] |
| 2 kΩ to 200 kΩ | LO Ω | ±[0.3% of reading +0.025% of full scale (5 counts)] |
| 20 MΩ | HI Ω | ±[1.2% of reading +0.025% of full scale (5 counts)] |
| 2000 kΩ | LO Ω | ±[1.2% of reading +0.025% of full scale (5 counts)] |

*[1] *Valid for six months or 1000 hours whichever occurs first.*

### DC AND TRUE RMS AC CURRENT

**Input Signal** — Must be between 5% and 100% of full scale (ac only).

**Ranges** — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.

**Dc Current Accuracy** — +18°C to +28°C: ±[0.2% of reading +0.015% of full scale (3 counts)]. 0°C to +18°C and +28°C to +50°C: ±[0.3% of reading + 0.025% of full scale (5 counts)].

**Ac Current Accuracy From 20 Hz to 10 kHz** — +18°C to +28°C: ±[0.6% of reading +0.05% of full scale (10 counts)]. 0°C to +18°C, +28°C to +50°C: ±[0.7% of reading +0.075% of full scale (15 counts)]. Usable to 20 kHz.

**Response Time** — <1 s dc current, <2 s ac current.

**Input Resistance** —

| Ranges | Approximate Resistance |
|---|---|
| 200 μA | 1.0 kΩ |
| 2 mA | 100.0 Ω |
| 20 mA | 10.2 Ω |
| 200 mA | 1.2 Ω |
| 2000 mA | 0.4 Ω |

**Maximum Open-Circuit Input Voltage (mA to LOW)** — 250 V peak, fused with 2 A fast blow.

**Maximum Floating Voltage** — 1000 V peak.

**Maximum Resolution** — 10 nA.

### TEMPERATURE

**Range** — −62°C to +240°C.

**Resolution** — 0.1°C.

**Accuracy*[1]**

| Temperature to be measured | −62°C | +150°C | +240°C |
|---|---|---|---|
| P6601 and DM 501A calibrated as a pair | ±2°C | 0°C to −6°C | |
| P6601 and instrument not calibrated as a pair | ±4°C | +2°C to −8°C | |

*[1] *+18°C to +28°C ambient temperature. For 0°C to +18°C, +28°C to +50°C ambient temperatures, add 1.5°C to above limit in each direction.*

### OTHER CHARACTERISTICS

**Overrange Indication** — Blinking display (except on 1000 V dc and 500 V ac ranges).

**Measurement Rate** — 3⅓/s.

**Power Consumption** — ≈9 W.

**Inputs** — Maximum input voltage is 1000 V. The front panel Volts/Ω, or Low, or mA terminals can be floated to 1000 V peak maximum above ground, the rear input only 200 V peak. For the rear input, ac volts, ohms, and maximum input specfications are derated.

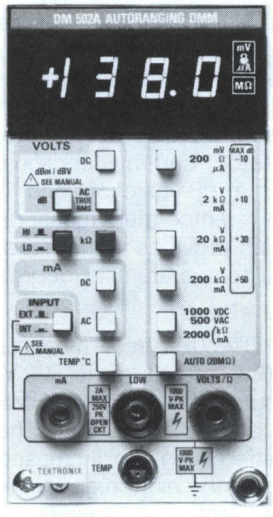
## ORDERING INFORMATION

**DM 501A** Digital Multimeter **$795**

**Includes:** One pair of test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual (070-2749-00).

**Option 02** — (Deletes P6601 Temperature Probe and temperature measurement capability). **−$100**

**DM 502A**




**Digital Multimeter**

# DM 502A

**True RMS**

**Autoranging**

**7 Functions Including Temperature and dB**

**0.1% Dc Volts Accuracy**

**3½ Digit Display**

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random or other nonsinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 V to 0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. The high voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3½ digit display.





**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

## CHARACTERISTICS

### DC VOLTS

**Ranges** — 2000 mV, 2 V, 20 V, 200 V, and 1000 V. Automatic or manual ranging.

**Accuracy*1**

**−18°C to +28°C**

| Voltage Ranges | Normal and Fast Conversion Rate |
|---|---|
| 20 mV to 200 V | ±[0.1% of reading +0.05% of full scale (1 count)] |
| 1000 V | ±[0.1% of reading +0.1% of full scale (1 count)] |

**0°C to +18°C, +28°C to +50°C**

| Voltage Ranges | Normal and Fast Conversion Rate |
|---|---|
| 200 mV to 200 V | ±[0.2% of reading +0.1% of full scale (2 counts)] |
| 1000 V | ±[0.2% of reading +0.2% of full scale (2 counts)] |

*1 *Valid for six months or 1000 hours, whichever occurs first.*

**Common-Mode Rejection Ratio** — ⩾100 dB at dc. ⩽80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

**Normal-Mode Rejection Ratio** — ⩾50 dB at 50 Hz or 60 Hz ±0.2 Hz.

**Maximum Resolution** — 100 μV.

**Step Response Time** — 1 s within a range, +1.5 s for each range change in autoranging mode.

**Input Resistance** — 10 MΩ.

**Maximum Input Voltage** — 1000 V peak.

### TRUE RMS AC VOLTS

**Ranges** — 200 mV, 2 V, 20 V, 200 V, and 500 V. Automatic or manual ranging (ac coupled).

**Accuracy*1**

| 0°C to +18°C | Normal and Fast Conversion Rate | |
|---|---|---|
| Voltage Ranges | 20 Hz to 40 Hz | 40 Hz to 20 kHz |
| 200 mV to 200 V | ±[1.5% of reading +0.3% of full scale (6 counts)] | ±[0.6% of reading +0.3% of full scale (6 counts)] |
| 500 V | ±[1.5% of reading +1.2% of full scale (6 counts)] | ±[0.6% of reading +1.2% of full scale (6 counts)] |

**0°C to +18°C, +28°C to +50°C**

| | Normal and Fast Conversion Rate | |
|---|---|---|
| Voltage Ranges | 20 Hz to 40 Hz | 40 Hz to 20 kHz |
| 200 mV to 200 V | ±[1.8% of reading +0.35% of full scale (7 counts)] | ±[0.8% of reading +0.35% of full scale (7 counts)] |
| 500 V | ±[1.8% of reading +1.4% of full scale (7 counts)] | ±[0.8% of reading +1.4% of full scale (7 counts)] |

*1 *Valid for six months or 1000 hours whichever occurs first. Typically usable to 100 kHz.*

**Common-Mode Rejection Ratio** — ⩾60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

**Maximum Resolution** — 100 μV.

**Resolution Time** — 1 s within a range, +1.5 s for each range change in autoranging mode.

**Input impedance** — 10 MΩ paralleled by <100 pF.

**Maximum Input Voltage** — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

**Crest Factor** — 4 (at full scale all ranges), ⩽2 on 500 V range.

### dB (TRUE RMS)

**Zero dB Reference** — 1 mW in 600 Ω (0.775 V) (dBm). Internal jumper change for 0 dB reference of 1,000 V (dBV).

**Accuracy*1**

| +18°C to +28°C | 20 Hz | 2 kHz | 10 kHz | 20 kHz |
|---|---|---|---|---|
| +50 dB to −50 dB | ±0.5 dB | | | |
| −50 dB to −60 dB | ±0.5 dB | ±1.5 dB | Typically ±2.5 dB | |

*1 *From 0°C to +18°C, +28°C to +50°C, add 0.6 dB to above accuracy specifications. For example, at 0°C the accuracy in the +50 dB to −50 dB range from 20 Hz to 20 kHz would be ±1.1 dB.*

**Noise Level** — Typically −75 dB.

**Maximum Resolution** — 0.1 dB.

**Response Time** — ⩽1 s within a range, ⩽1.5 s for each range change in autoranging mode.

**Input Impedance** — 10 MΩ paralleled by <100 pF.

**Maximum Input Voltage** — 500 V RMS, not to exceed 1000 V peak.

**Crest Factor** — 4 (at full scale), ⩽2 above 40 dB.

### RESISTANCE

**Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ. Automatic or manual ranging.

**Accuracy*1**

**+18°C to +28°C**

| Resistance Ranges | |
|---|---|
| 200 Ω to 2000 kΩ | ±[0.5% of reading +0.05% of full scale (1 count) + 0.2 Ω] |
| 20 MΩ | ±[1% of reading +0.05% of full scale (1 count)] |

**0°C to +18°C, +28°C to +50°C**

| Resistance Ranges | |
|---|---|
| 200 Ω to 2000 kΩ | ±[0.8% of reading +0.1% of full scale (2 counts) + 0.2 Ω] |
| 20 MΩ | ±[1.3% of reading +0.1% of full scale (2 counts)] |

*1 *Valid for six months or 1000 hours whichever occurs first.*

**Response Time** — ⩽1 s within a range, ⩽1.5 s for each range change in autoranging mode.

**Maximum Input Volts** — 130 V dc or ac RMS indefinitely. 230 V dc or ac RMS for 30 minutes maximum.

**HI-LO Ohm Operation** — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

**Maximum Resolution** — 0.1 Ω.

**Maximum Open-Circuit Voltage Developed** — ≈14 V.

### DC AND TRUE RMS AC CURRENT

**Ranges** — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA. Manual ranging only.

**Dc Current Accuracy** — +18°C to +28°C: ±[0.2% of reading +0.05% of full scale (1 count)]. 0°C to +18°C, +28°C to +50°C: ± [0.3% of reading +0.1% of full scale (2 counts)].

**Ac Current Accuracy (From 40 Hz to 10 kHz)** — Usable to 20 kHz. +18°C to +28°C: ±[0.6% of reading +0.3% of full scale (6 counts)]. 0°C to +18°C, +28°C to +50°C: ±[0.7% of reading +0.5% of full scale (10 counts)].

**Response Time** — ⩽1 s.

**Input Resistance**

| Ranges | Approximate Resistance |
|---|---|
| 200 μA | 1.0 kΩ |
| 2 mA | 100.0 Ω |
| 20 mA | 10.2 Ω |
| 200 mA | 1.2 Ω |
| 2000 mA | 0.4 Ω |

**Maximum Open Circuit Input Voltage (mA to LOW)** — 250 V peak, fused with 2 A fast blow.

**Maximum Floating Voltage** — 1000 V peak.

**Maximum Resolution** — 0.1 μA.

### TEMPERATURE

**Range** — −55°C to +200°C.

**Resolution** — 0.1°C.

**Accuracy*1**

**+18°C to +28°C**

| Temperature to be Measured | −55°C | +150°C | +200°C |
|---|---|---|---|
| P6601 Probe and DM 502A calibrated as a pair | ±2.5°C | | ±3.5°C |
| P6601 and instrument not calibrated as a pair | ±4.5°C | | ±5.5°C |

*1 *For 0°C to +18°C, +28°C to +50°C ambient temperatures, add ±1.5°C to accuracy specifications.*

### OTHER CHARACTERISTICS

**Overrange Indication** — Blinking display (except 1000 V dc and 500 V ac).

**Measurement Rate** — Three per second.

**Power Consumption** — ≈8 W.

**Inputs** — Maximum input voltage is 1000 V. The front panel V/Ω, or Low, or mA terminal can be floated 1000 V peak maximum above ground, the rear input 200 V peak. For the rear input, ac volts, ohms and maximum input specifications are derated.

## ORDERING INFORMATION

**DM 502A** Digital Multimeter **$750**

**Includes:** One pair test leads (003-0120-00); P6601 Temperature Probe (010-6601-01); instruction manual (070-2693-00).

**Option 02** — (Deletes temperature probe and capability.) **−$100**

## DIGITAL MULTIMETER PROBES & OPTIONAL ACCESSORIES

### High Voltage Probe

The High Voltage Probe will measure dc voltages from 1 kV to 40 kV with an accuracy of 1% at 25 kV. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes. Probe plugs directly into the front end of the multimeter.

### CHARACTERISTICS

**Voltage Range** — 1 kV to 40 kV dc.

**Input Resistance** — 1000 MΩ.

**Division Ratio** — 1000:1.

**Overall Accuracy** — 20 kV to 30 kV 2%.

**Upper Limit Accuracy** — Changes linear from 2% at 30 kV to 4% at 40 kV.

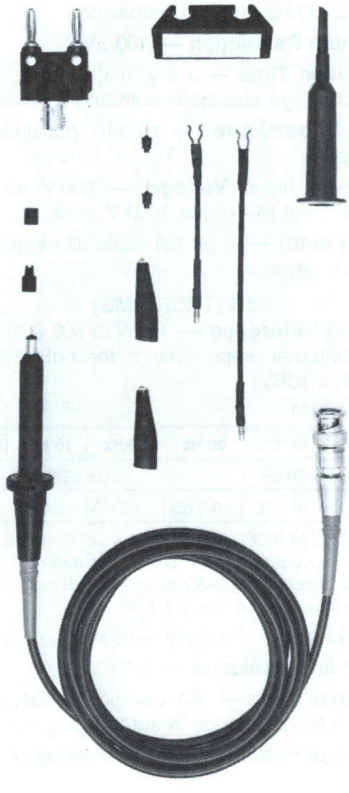
**Lower Limit Accuracy** — Changes linear from 2% at 20 kV to 4% at 1 kV.

**Input Z at Meter** — 10 MΩ required.

### ORDERING INFORMATION

**High Voltage Probe.** Order 010-0277-00 **$165**

### P6420 RF Probe



The P6420 RF Probe is compatible with DMM's that have an input impedance of 10 MΩ and comes with a two meter cable.

### CHARACTERISTICS

**Voltage Range** — 5 V to 25 V RMS (70.7 V p-p).

**Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

**Frequency Response** — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

**Input Capacitance** — ≈3.7 pF.

**Maximum Input Voltage** — 42.4 V (peak ac + dc).

**Length** — Probe only 96 mm. Cable only 2 meters.

### ORDERING INFORMATION

**P6420** RF Probe, 2 m Cable Included. Order 010-6420-03 **$145**

**Includes:** Retractable probe tip (013-0097-01); BNC female to dual banana adaptor (103-0090-00); alligator clip (344-0046-00); probe holder (352-0351-00); 76.2 mm (3 in) ground lead (175-0849-00); 152.8 mm (6 in) ground lead (175-1017-00); two replaceable probe tips*[1]; electrical insulating sleeve (166-0404-01); data sheet (062-2764-00).

*[1] *Available in package of ten only, Order 206-0230-03.*

**For a 1 Meter Length Cable** (does not change specifications). Order 175-1661-00 **$27**

**For a 3 Meter Length Cable** (does not change specifications). Order 175-1661-02 **$27**

### P6601 Temperature Probe

The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the probe tip to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 seconds ±0.2 seconds. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a maximum of +240°C, and cable is limited to a maximum of +140°C.

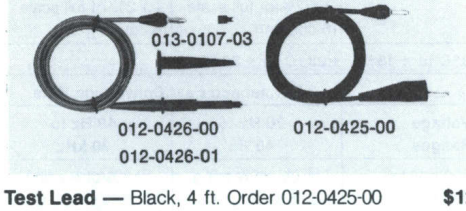
### ORDERING INFORMATION

**P6601** Temperature Probe
Order 010-6601-01 **$210**

**Includes:** Instruction manual (070-2620-00).

### DMM OPTIONAL ACCESSORIES

The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.




**Test Lead** — Black, 4 ft. Order 012-0425-00 **$12**

**Test Lead** — Red, 4 ft. Order 012-0426-00 **$22**

**Test Lead** — Black, 4 ft. Order 012-0426-01 **$22**

**Test Lead** — Set (012-0425-00, 012-0426-00, 013-0107-03). Order 012-0427-00 **$29**

**Adaptor** — Female BNC to Dual Banana. Order 103-0090-00 **$7.50**

**Additional accessories begin on page 426.**

The TM 500 Pulse Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The PG 507 features complementary dual outputs making it ideally suited for digital applications. The dual output feature is particularly useful when working with ECL logic families.

Similar to the PG 507 Pulse Generator is the 50 MHz PG 508 featuring independently variable risetimes and falltimes. The PG 508's high level performance and versatility cover a broad range of test and measurement applications.

The accurate 50 ohm output impedances of the PG 507 and PG 508 deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50 MHz multipurpose generators are also designed for high level performance on high impedance circuits (MOS, HTL, and CMOS logic).

In 50 ohm systems, the PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families (TTL, DTL and ECL), in repetition rates, amplitudes and transition times.

The TM 500 Pulse Generators' wide range of features afford you ease of operation even on the most challenging test and measurement problems.

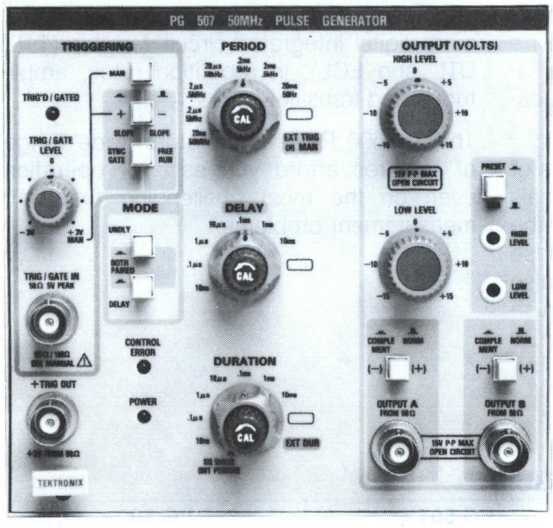
## PULSE GENERATORS SELECTION GUIDE

| APPLICATION/FEATURE | PG 507 | PG 508 | PG 501 | PG 502 |
|---|---|---|---|---|
| Pulse Period | ≤20 ns to ≥200 ms (50 MHz to 5 Hz) | | ≤20 ns to ≥200 ms (50 MHz to 5 Hz) | ≤4 ns to ≥100 ms (250 MHz to 10 Hz) |
| Pulse Duration Duty Factor | ≤10 ns to ≥100 ms | | ≤10 ns to ≥100 ms | ≤2 ns to ≥50 ms |
| | ≥70% to 0.2 μs period, ≥50% at 20 ns period | | | ≥50% |
| Squarewave Mode | ✓ | ✓ | | ✓ |
| Pulse Delay Duty Factor | ≤10 ns to ≥100 ms*1 | ≤10 ns to ≥100 ms*1 | | |
| | ≥70% to 0.2 μs period, ≥50% at 20 ns period | | Fixed, 20 ns from external trigger | Fixed, 17 ns from external trigger |
| Double Pulse | ✓ | ✓ | | |
| Transition Times | Fixed, ≤3.5 ns, ≤4 ns @ >5 V | ≤5.5 ns to ≥50 ms, Independently variable up to 100:1 | Fixed, ≤3.5 ns | Fixed ≤1.0 ns |
| Aberrations | ≤5% p-p +25 mV into 50 Ω load | ≤5% p-p +50 mV for pulse within ±5 V into 50 Ω load | Within 3.5% at 5 V into 50 Ω load | Within 5% at 5 V p-p (durations ≥5 ns) |
| Amplitude: Into 50 Ω | ≥7.5 V p-p, ±7.5 V window | ≥10 p-p, ±10 V window | ≥5 V | 5 V, ±5 V window |
| Open Circuit | ≥15 V p-p, ±15 V window | ≥20 p-p, ±20 V window | Not specified | 5 V, ±5 V window |
| Source Impedance | 50 Ω | 50 Ω | Not specified | 1 kΩ or 50 Ω |
| Simultaneous Outputs | ✓, complementary | | ✓, positive and negative | |
| Pulse Coincidence | ≤1 ns at 50% amplitude | NA | ≤1 ns at 50% amplitude | NA |
| Output Controls | Independent pulse top and pulse bottom, normal or PRESET | | Independent amplitude controls for + and − outputs, no offset | Independent pulse top and pulse bottom |
| Normal/Complement | ✓, both outputs | ✓ | | ✓ |
| Remote Amplitude | Rear interface inputs | Rear interface inputs | | |
| Locked On Mode | | | ✓ | |
| Back Termination | Always back terminated | Always back terminated | | ✓, switchable |
| External Input | 1 MΩ to 50 Ω input impedance | 1 MΩ or 50 Ω input impedance | 50 Ω input Z | 50 Ω input Z |
| Trigger Level | −3 V to +3 V, 80 mV p-p sensitivity to 10 MHz<br>250 mV p-p to 50 MHz TRIG'D/GATED light | | +1 V required | +1 V required |
| Slope | + or − | + or − | + Only | + Only |
| Trigger Mode | ✓ | ✓ | ✓ | ✓ |
| Manual Trigger | ✓ | ✓ | | ✓ |
| Duration Mode | ✓ | ✓ | ✓ | ✓ |
| Gate Mode | ✓ | ✓ | | |
| Counted Burst | ✓, with DD 501*2 | ✓, with DD 501*2 | | |
| Trigger Output (50% Squarewave or Follows External Signal) | ≥+2 V from 50 Ω approximately 35 ns prior to pulse output (23 ns in squarewave or EXT DUR modes) | | ≥+2 V from 50 Ω, approximately 8 ns prior to pulse output | ≥+2 V from 50 Ω, approximately 10 ns prior to pulse output |
| Custom Timing Positions | User installed capacitors | User installed capacitors | No | No |
| Control Error Light | ✓ | ✓ | | |
| Mainframe Compatibility | TM 500/TM 5000 | TM 500/TM 5000 | TM 500/TM 5000 | TM 500/TM 5000 |
| Page | 368 | 368 | 369 | 369 |
| Prices Begin At | $2,525 | $2,325 | $850 | $3,045 |

*1 *Add 60 ns for delay from external trigger.*
*2 *Exact count to 20 MHz, usable to 50 MHz.*

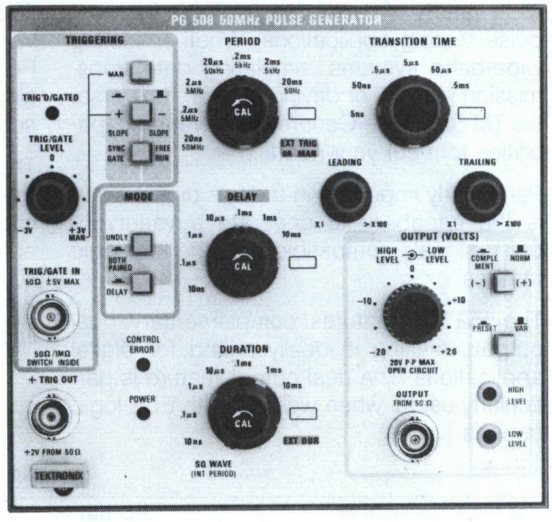
**For recommended accessories see page 448.**

PG 507




50 MHz Dual Output Pulse Generator

PG 508




50 MHz Pulse Generator

# PG 507

**Dual Outputs with Tracking Level Controls**

**Normal or Complement Pulse Output on Both Channels**

**15 V Output in a ±15 V Window into High Impedance, 7.5 V into 50 Ω**

**3.5 ns Risetime/Falltime**

The PG 507 is a high performance, 50 MHz pulse generator designed specifically for logic design applications.

The PG 507 features complementary dual outputs which greatly increase its applicability in logic design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and simultaneous positive mode (Channel A positive going Channel B output positive going).

In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic design or control applications requiring simultaneous signals.

## ORDERING INFORMATION

**PG 507** 50 MHz Pulse Generator **$2,525**
**Includes:** Instruction manual (070-2962-00).

**P6062B, P6108A and P6122 Probes are recommended, see pages 432, 430 and 431 respectively.**

# PG 508

**Independently Variable Risetimes and Falltimes to 5 ns**

**20 V Output in a ±20 V Window to Hi Impedance, 10 V into 50 Ω**

**Normal or Complement Output**

The PG 508 50 MHz Pulse Generator is a highly versatile, general purpose pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real world waveforms. This capability is particularly useful in research and development applications demanding versatility in risetimes and falltimes like testing of amplifiers, slew rate testing, comparator simulation and logic circuitry performance tests.

For example, controllable risetimes and falltimes are extremely desirable when working with CMOS where logic power consumption increases with slower risetimes. Also, variable risetimes and falltimes are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the risetimes and falltimes controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different risetimes and falltimes, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508 is the capability of changing output amplitude while variable risetimes and falltimes remain constant.

## ORDERING INFORMATION

**PG 508** 50 MHz Pulse Generator **$2,325**
**Includes:** Instruction manual (070-2044-01).

**PG 508T** 50 MHz Pulse Generator **$2,740**
**Includes:** PG 508, TM 503 Mainframe, and 016-0195-03 Blank Panel.

**For counted Burst, order the DD 501** Digital Delay (page 374) **$1,600**
Suggested 10 in BNC 50 Ω cable (2 required) for interconnecting PG 508 and DD 501:
Order 012-0208-00 **$22**

**P6062B, P6108A and P6122 Probes are recommended, see pages 432, 430 and 431 respectively.**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

### Manual (One-Shot) Trigger Generator

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501.

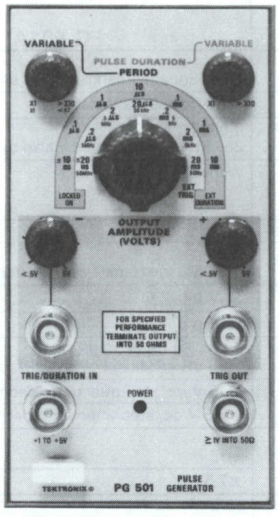
The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally 2 ms in width and 3 V in amplitude (from 50 Ω) with a rapid risetime and falltime.

**ORDERING INFORMATION**

**Trigger Generator** 016-0597-00 **$170**

### PG 501




**50 MHz Pulse Generator**

## PG 501

**5 Hz to 50 MHz**

**Simultaneous Plus and Minus Outputs**

**5 V and 3.5 ns into 50 Ω**

**Independent Period and Duration Controls**

**Trigger Out**

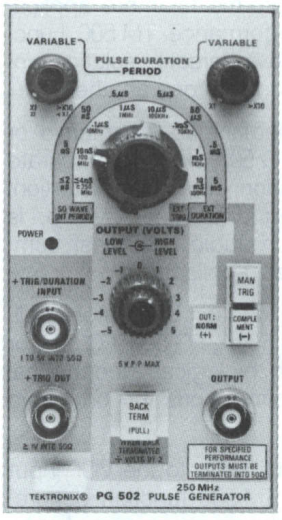
The PG 501 is a 50 MHz Pulse Generator featuring simultaneous plus and minus outputs, a wide range of pulse-period durations and duty factors, trigger output and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

**ORDERING INFORMATION**

**PG 501** 50 MHz Pulse Generator **$850**

**Includes:** Instruction manual (070-1361-01).

### PG 502




**250 MHz Pulse Generator**

## PG 502

**10 Hz to 250 MHz**

**1 ns Risetime**

**5 V Output ±5 V Window**

**Independent Pulse Top and Bottom Level Controls**

**Selectable Internal Reverse Termination**

**Manual Trigger Button**

The PG 502 features fast risetimes and falltimes, independent top and bottom pulse levels, and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

**ORDERING INFORMATION**

**PG 502** 250 MHz Pulse Generator **$3,045**

**Includes:** Instruction manual (070-1598-01).

**50 Ω Precision Coaxial Cable**

For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

**ORDERING INFORMATION**

**50 Ω Cable** Order 012-0482-00 **$25**

When your test and measurement problems require more waveforms for more applications, the high performance TM 500 Function Generators are a versatile solution singly or in combination with one another.

For applications demanding logarithmic or linear sweep the FG 507 offers an accurate and versatile solution. The low distortion, combined with log and linear sweep, is particularly useful in audio and linear communications-oriented applications.

For low-frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical and mechanical simulations or on servo systems.

Applying an external ramp to the VCF input allows any of the TM 500 function generators to double as sweep generators. Applying a suitable modulating signal can produce a frequency-modulated carrier. In addition, the FG 504 and FG 507 can supply internally generated linear or logarithmic sweeps with convenient two-dial control of start and stop frequencies.

Sweeping wide frequency ranges (up to 1000:1) with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform in the gated burst or triggered mode with the FG 501A, FG 504, FG 507 and the FG 5010. A gated or triggered waveform efficiently tests tone-controlled systems, loud speaker transient response characteristics, automatic gain control circuits, or other amplitude sensitive systems.

The FG 504's phase lock mode feature lets you convert digital signals to high or low voltage sinewaves, pulses, or triangles; ideal for locking the function generator's output to a house or system frequency standard. With the DD 501 Digital Delay Generator in the "divide by n" mode, the FG 504 can be locked to your frequency reference at a lower frequency.

## FUNCTION GENERATORS

| APPLICATION/ FEATURE | FG 501A | FG 507 |
|---|---|---|
| **Waveforms** | Sine, Square, Triangle, Pulse and Ramp with variable symmetry | |
| **Symmetry** | ⩽5% to ⩾95% Variable | ⩽5% to >95% Variable |
| **Frequency Range** | 0.002 Hz to 2 MHz<br>200 kHz ±10% with variable symmetry on | 0.002 Hz to 2 MHz<br>200 kHz ±10% with variable symmetry on |
| **Dial Accuracy (% of Full Scale) (except FG 5010)** | Within 3% | Within 3%<br>Within 5% in sweep mode*2 |
| **Custom Frequency Range** | No | No |
| **Frequency Stability (% of Full Scale)** | ⩽0.05% for 10 min., ⩽0.1% for 1 hour, ⩽0.5% for 24 hours, constant temperature | |
| **Amplitude: Open Circuit** | 30 V p-p | 30 V p-p |
| **Into 50 Ω** | 15 V p-p | 15 V p-p |
| **Attenuator** | 0 to −60 dB in 20 dB steps<br>>20 dB additional with AMPL control | |
| **Offset: Open Circuit** | ±13 V dc, step attenuator decreases offset | |
| **Into 50 Ω** | ±6.5 V dc, step attenuator decreases offset | |
| **Pk Sig + Offset: Open Circuit** | ±15 V | ±15 V |
| **Into 50 Ω** | ±7.5 V | ±7.5 V |
| **Output Impedance** | 50 Ω | 50 Ω |
| **Amplitude Flatness (10 kHz ref, 50 Ω load) Sine-wave** | ±0.1 dB 20 Hz to 20 kHz<br>±0.5 dB 20 kHz to 1 MHz<br>±1 dB 1 MHz to 2 MHz | ±0.1 dB 20 Hz to 20 kHz<br>±0.5 dB 20 kHz to 1 MHz<br>±1 dB 1 MHz to 2 MHz |
| **Triangle** | ±0.5 dB 20 Hz to 200 kHz<br>±2 dB 200 kHz to 2 MHz | ±0.5 dB 20 Hz to 200 kHz<br>±2 dB 200 kHz to 2 MHz |
| **Square-wave** | ±0.5 dB 20 Hz to 2 MHz | ±0.5 dB 20 Hz to 2 MHz |
| **Sinewave Distortion (Maximum Output, 50 Ω load)** | ⩽0.25% 20 Hz to 20 kHz*2<br>⩽0.5% 20 kHz to 100 kHz<br>Harmonics:<br>⩽−30 dB, 100 kHz to 2 MHz | ⩽0.25% 20 Hz to 20 kHz*2<br>⩽0.5% 20 kHz to 100 kHz<br>Harmonics:<br>⩽−30 dB, 100 kHz to 2 MHz |
| **Squarewave Response** | ⩽25 ns rise/fall<br><3% p-p aberrations | ⩽25 ns rise/fall<br><3% p-p aberrations |
| **Triangle Linearity (10% to 90%)** | ⩾99% 20 Hz to 200 kHz<br>⩾97% 200 kHz to 2 MHz | ⩾99% 20 Hz to 200 kHz<br>⩾97% 200 kHz to 2 MHz |
| **Trigger Output** | ⩾+4 V from 50 Ω | ⩾+4 V from 50 Ω |
| **External Input** | Impedance ≈2 kΩ<br>Trigger threshold level +1 V ±20% | Impedance ≈2 kΩ<br>Trigger threshold level +1 V ±20% |
| **Trigger** | ±90° variable start phase control | ±90° variable start phase control |
| **Gate** | ±90° variable start phase control | ±90° variable start phase control |
| **Phase Lock** | No | No |
| **Counted Burst** | With DD 501 | With DD 501 |
| **Internal Sweep** | No | Logarithmic or Linear, Separate Start/Stop Dials |
| **Duration** | NA | 1 ms to 100 s |
| **External Trigger** | | ±1 V ±20 % trigger level<br>≈2 kΩ input impedance |
| **Ramp Output** | | ⩽0.3 V to 10 V from 1 kΩ ±5% |
| **Gate Output** | | ⩾+4 V from 50 Ω |
| **Other Modes** | | Manual Sweep Trig<br>Manual Sweep<br>Sweep and Hold |
| **Amplitude Modulation** | No | No |
| **Voltage Controlled Frequency (FM)** | Up to 1000; 1 Frequency change with 10 V external signal<br>Slew rate ⩾0.3 V/μs, 10 kΩ input impedance | |
| **Nominal Hz/Volt Sensitivity** | 2 x Frequency Multiplier setting | 2 x Frequency Multiplier |
| **Output Hold Mode** | No | No |
| **Temperature*4** | 0°C +50°C Operating, −55°C to +75°C Nonoperating | |
| **IEEE Standard 488** | No | No |
| **Mainframe Compatibility** | TM 500/TM 5000 | TM 500/TM 5000 |
| **Page** | 372 | 373 |
| **Price** | $925 | $1,850 |

**1 +15° C to +35° C ambient*
**2 +20° C to +30° C ambient*
**3 20 Hz to 20 kHz modulation frequency*
**4 FG 504 requires forced air circulation above +40° C.*
**5 Percent of indicated frequency*
**6 Absolute voltage accuracy*
**7 Separate FM function provided (1%/V)*

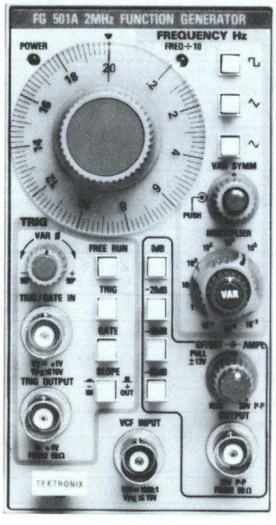
Compatible accessories begin on page 448.

## SELECTION GUIDE

| APPLICATION/ FEATURE | FG 504 | FG 502 | FG 503 | FG 5010 |
|---|---|---|---|---|
| **Waveforms** | Sine, Square, Triangle, Pulse and Ramp with variable symmetry | Sine, Square, Triangle Pulse, or Ramp | Sine, Square, Triangle | Sine, Square, Triangle, Pulse and Ramp with variable symmetry |
| **Symmetry** | 7% to 93% Variable | 5%, 50%, 95% Fixed | 50% Fixed | 10% to 90%, 1% steps |
| **Frequency Range** | 0.001 Hz to 40 MHz<br>4 MHz nominal with variable symmetry on | 0.1 Hz to 11 MHz<br>Pulse and Ramp, 1.1 MHz | 1.0 Hz to 3 MHz<br>Usable 0.01 Hz to 5 MHz | 0.002 Hz to 20 MHz |
| **Dial Accuracy (% of Full Scale) (except FG 5010)** | Within 3% to 4 MHz*1<br>Within 6% to 40 MHz*1 | Within 3% to 1 MHz<br>Within 5% to 10 MHz | Within 5% | Within 0.1% of selected frequency<br>Digital LED Display |
| **Custom Frequency Range** | Shipped with capacitor for 20 Hz to 20 kHz | No | With user-installed capacitor | NA |
| **Frequency Stability (% of Full Scale)** | ≤0.05% for 10 minutes, ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature | | | ≤0.05% for 1 hr, 0.05% for 24 hrs (≤0.1% in trigger, gate, burst mode <200 Hz)*5 |
| **Amplitude: Open Circuit** | 30 V p-p | 10 V p-p | 20 V p-p | 20 V p-p |
| **Into 50 Ω** | 15 V p-p | 5 V p-p | 10 V p-p | 10 V p-p |
| **Attenuator** | 0 to −50 dB in 10 dB steps<br><10 mV p-p with VAR control | Variable control only | Variable control only | Digital Control of fixed and variable<br>10 mV p-p into 50 Ω |
| **Offset: Open Circuit** | ±7.5 V dc | ±5 V dc | ±7.5 V dc | ±7.5 V dc |
| **Into 50 Ω** | ±3.75 V dc | ±2.5 V dc | ±3.75 V dc | ±3.75 V dc |
| **Pk Sig + Offset: Open Circuit** | ±20 V | ±10 V | ±15 V | ±15 V |
| **Into 50 Ω** | ±11.25 V | ±5 V | ±6 V | ±7.5 V |
| **Output Impedance** | 50 Ω | 50 Ω | 50 Ω | 50 Ω |
| **Amplitude Flatness (10 kHz ref, 50 Ω load) Sine-wave** | ±0.5 dB 0.001 Hz to 40 kHz | ±0.5 dB 20 Hz to 20 kHz<br>±1.5 dB 0.1 Hz to 11 MHz | ±0.5 dB 20 Hz to 20 kHz<br>±2 dB 0.1 Hz to 3 MHz | ±3% from 0.002 Hz to 1 kHz<br>±3.5% from 1 kHz to 1 MHz<br>±5% from 1 MHz to 5 MHz<br>+5%, −10% from 5 MHz to 20 MHz |
| **Triangle** | ±2 dB 40 kHz to 40 MHz | ±3 dB referenced to Sinewave | ±1 dB referenced to Sinewave | ±2% from 0.002 Hz to 1 kHz<br>±3.5% from 1 kHz to 100 kHz<br>±4% from 100 kHz to 1 MHz<br>+4%, −5% from 1 MHz to 5 MHz<br>+4%, −20% from 5 MHz to 20 MHz |
| **Square-wave** | ±0.5 dB to 20 MHz<br>±2 dB to 40 MHz | | | ±2% from 0.002 Hz to 1 kHz<br>±3.5% from 1 kHz to 1 MHz<br>±5% from 1 MHz to 10 MHz<br>±10% from 10 MHz to 20 MHz |
| **Sinewave Distortion (Maximum output, 50 Ω load)** | ≤0.5% 20 Hz to 40 kHz*1<br>Harmonics:<br>≤−30 dB 40 kHz to 1 MHz<br><−20 dB 1 MHz to 40 MHz | ≤0.5% 10 Hz to 50 kHz*2<br>Harmonics:<br>≤−30 dB at all other frequencies | ≤0.5% 1 Hz to 30 kHz<br>≤1.0% 30 kHz to 300 kHz<br>≤2.5% 300 kHz to 3 MHz | ≤0.5% 20 Hz to 19.99 kHz*1<br>≤1.0% 20 kHz to 99.99 kHz<br>Harmonics >30 dB down, 100 kHz to 20 MHz |
| **Squarewave Response** | ≤6 ns rise/fall fixed 10 ns to 100 ms variable<br>≤5% p-p +30 mV aberrations | ≤20 ns rise/fall<br>≤3% p-p aberrations | ≤60 ns rise/fall<br>≤3 p-p aberrations | ≤10 ns rise/fall<br>≤5% p-p aberrations |
| **Triangle Linearity (10% to 90%)** | ≥99% 10 Hz to 400 kHz<br>≥95% 400 kHz to 40 MHz<br>type ≥98% 0.001 Hz to 10 Hz | ≥99% 0.1 Hz to 100 kHz<br>≥97% 100 kHz to 1 MHz<br>≥95% 1 MHz to 11 MHz | ≥99% 1 Hz to 100 kHz<br>≥95% 100 kHz to 3 MHz | >98% to 2 MHz<br>>90% to 20 MHz |
| **Trigger Output** | ≥+2 V from 50 Ω | +2.5 V to 50 Ω load | +2.5 V to 600 Ω load | +2 V from 50 Ω |
| **External Input** | Impedance ≥10 kΩ<br>Sensitivity ≤1 V p-p<br>Trigger level −1 V to +10 V | Impedance ≈1 kΩ<br>≥+2 V Gate Signal required | No | 1 MΩ/50 Ω internal setability<br>0.0 V/0.5 V internal setability |
| **Trigger** | 20 MHz maximum<br>±80° start phase control to 10 MHz | No | No | ±90° variable start phase control |
| **Gate** | | Fixed 0° start phase | No | ±90° variable start phase control |
| **Phase Lock** | 100 Hz to 40 MHz<br>±80° phase range | No | No | 20 Hz to 20 MHz<br>(Auto Scan) |
| **Counted Burst** | With DD 501 | With DD 501 | No | 1 to 9999 |
| **Internal Sweep** | Logarithmic or Linear, Separate Start/Stop Dials | No | No | No |
| **Duration** | 0.1 ms to 100 s | NA | NA | NA |
| **External Trigger** | +1 V to +10 V trigger level<br>1 V p-p sensitivity | | | |
| **Ramp Output** | 0 to +10 V from 1 kΩ<br>±5% to 1 ms, ±10%<br>≤1 ms | | | |
| **Gate Output** | No | | | |
| **Other Modes** | Manual Sweep Trig | | | |
| **Amplitude Modulation** | 100% with nominal 5 V p-p input<br>Dc to 100 kHz modulation frequency<br><5% distortion to 4 MHz at 70%*3<br><10% distortion to 40 MHz at 65%*3 | No | No | 100% with nominal 5 V p-p input<br>Dc to 100 kHz modulation frequency<br><2% distortion to 2 MHz at 70%<br><4% distortion to 20 MHz at 70% |
| **Voltage Controlled Frequency (FM)** | Up to 1000: 1 Frequency change with 10 V external signal<br>Slew rate ≥0.3 V/ms, 10 kΩ input impedance | | | Up to 1000: 1 frequency*7<br>change with 10 V external input |
| **Nominal Hz/Volt Sensitivity** | 4 x Frequency Multiplier | 1.1 x Frequency Multiplier | 3 x Frequency Multiplier | 10% of selected range |
| **Output Hold Mode** | 0.001 Hz to 400 Hz | No | No | 0.002 Hz to 200 Hz |
| **Temperature*4** | 0°C to +50°C Operating, −55°C to +75°C Nonoperating | | | |
| **IEEE Standard 488** | No | No | No | Yes |
| **Mainframe Compatibility** | TM 500/TM 5000 | TM 500/TM 5000 | TM 500/TM 5000 | TM 5000 only |
| **Page** | 373 | 372 | 372 | 345 |
| **Prices** | $3,225 | $1,095 | $675 | $3,995 |

**Compatible accessories begin on page 448.**

FG 501A




2 MHz Function Generator

# FG 501A

**0.002 Hz to 2 MHz**

**30 V Peak-to-Peak, ±13 V Offset**

**5% to 95% Variable Symmetry**

**Trigger or Gate, ± Slope**

**60 dB Step Attenuator**

**≤0.25% Sinewave Distortion**

**≤25 ns Rise/Fall**

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms—sinewave, squarewave, triangle, ramp, and pulse—at output levels up to 30 V peak-to-peak with up to ±13 V of offset from a 50 Ω source. Waveform triggering and gating are provided with a variable phase control to permit up to ±90° of phase shift for generating haver-sines, $\sin^2$ pulses, and haver triangles. A step attenuator provides 60 dB of output signal attenuation in 20 dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse risetime is ≤25 ns. Audio sinewave distortion is ≤0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low distortion sinewaves, the FG 501A is uniquely appropriate for applications demanding audio signals.

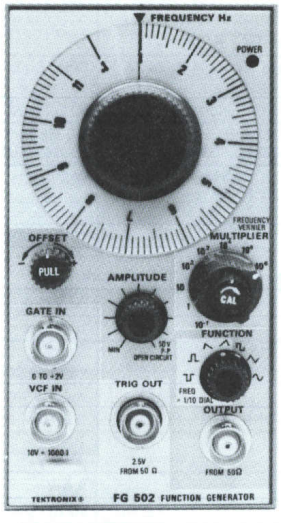
Also useful in audio applications is the 0 dB to 60 dB attenuator designed into the FG 501A.

The wide range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

## ORDERING INFORMATION

**FG 501A** 2 MHz Function Generator **$925**
**Includes:** Instruction manual (070-2957-00).

FG 502




11 MHz Function Generator

# FG 502

**0.1 Hz to 11 MHz**

**Five Waveforms**

**VCF and Gated Burst**

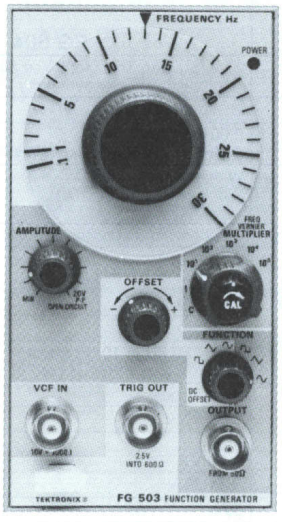
The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 MHz to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. VCF input permits the FG 502 to be used as a sweep generator or as an FM generator.

The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireless or radio remote control equipment and in certain phases of the telephone industry.

## ORDERING INFORMATION

**FG 502** 11 MHz Function Generator **$1,095**
**Includes:** Instruction manual (070-1706-01).

FG 503




3 MHz Function Generator

# FG 503

**1.0 Hz to 3 MHz**

**Three Waveforms**

**VCF**

The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multipler steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V peak-to-peak can be developed across a 50 Ω load (20 V peak-to-peak open circuit). Selectable offset up to 3.75 V dc across 50 Ω (7.5 V dc open circuit) is also featured.

## ORDERING INFORMATION

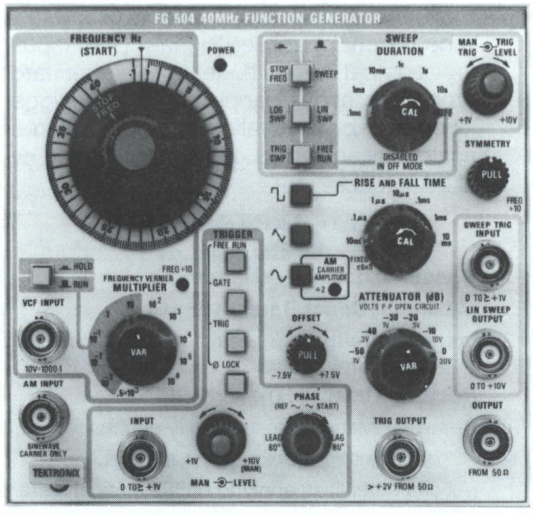
**FG 503** 3 MHz Function Generator **$675**
**Includes:** Instruction manual (070-1727-01).





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

**FG 504**




**40 MHz Function Generator**

# FG 504

**0.001 Hz to 40 MHz**

**Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Risetimes and Falltimes and Symmetry Controls**

**Logarithmic or Linear Sweep**

**Up to 30 V P-P Output**

**Built-In Attenuator**

**AM and FM**

**Phase Lock Mode**

**External and Manual Trigger or Gate**

**Counted Burst with DD 501**

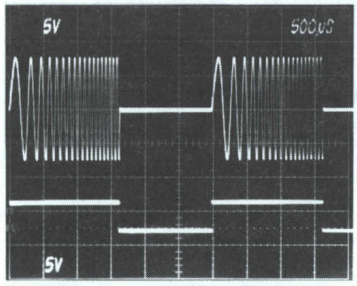
The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sinewaves, as well as adjust phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be swept, or amplitude or frequency modulated by external signals. In addition, the FG 504 can supply internally generated linear or logarithmic swept frequencies of up to 1000:1 range with convenient control of start and stop frequencies.

The FG 504 also provides trigger output, external voltage control input, and sweep output.

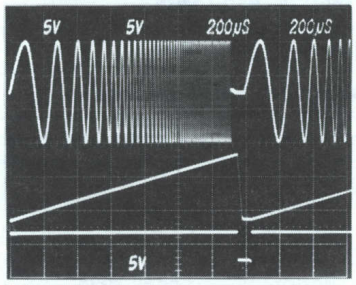
## ORDERING INFORMATION

**FG 504** 40 MHz Function Generator **$3,225**
**Includes:** Instruction manual (070-2655-00).

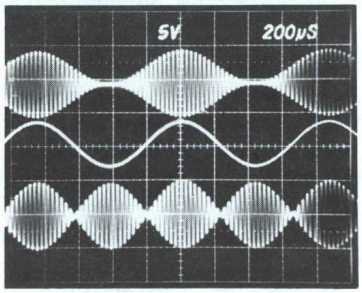
**FG 504T** 40 MHz Function Generator **$3,640**
**Includes:** FG 504, TM 503 Mainframe, and 016-0195-03 Blank Panel.



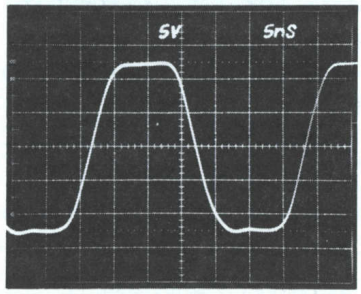

*FG 507 triggered sweep mode with output gated on by sweep gate.*




*FG 507 in logarithmic sweep with sweep ramp and gate outputs.*

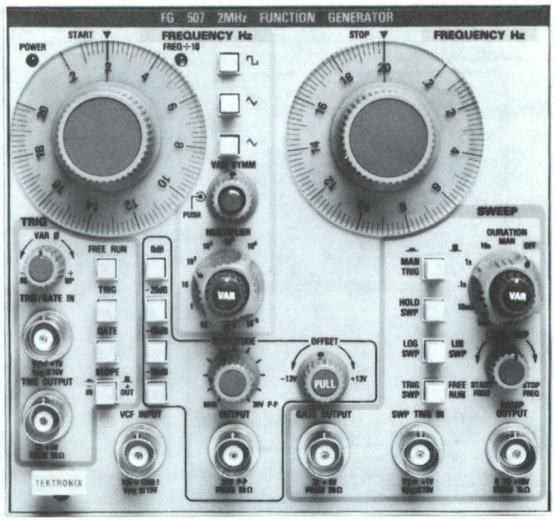



*True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.*




*FG 504 30 volt output with 6 ns risetime and falltime for superior pulse waveforms.*

**FG 507**




**2 MHz Sweeping Function Generator**

# FG 507

**0.002 Hz to 2 MHz**

**Includes All FG 501A Features**

**Logarithmic or Linear Sweep**

**Separate Start/Stop Frequency Dials**

**Sweep Up or Down**

**Sweep and Hold**

**Manual Sweep**

The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use log and linear sweep capability.

The log sweep of the FG 507 is mathematically correct and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503. Separate start and stop frequency dials make frequency settings easy to adjust and interpret. The instrument can be internally or externally swept up or down. A third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep gate output can be used to gate (burst) the generator on for swept bursts. The sweep hold mode allows the generator to sweep to the stop frequency and remain there until released.

The accurate log/linear sweep capability of the FG 507 plus the low distortion (0.25% over the audio range) make it ideally suited to audio testing.

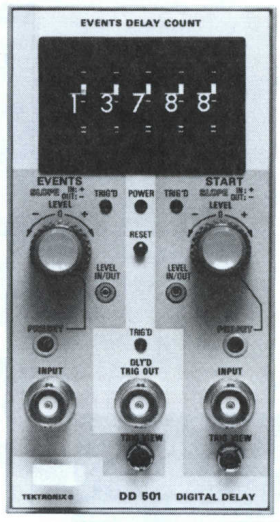
## ORDERING INFORMATION

**FG 507** 2 MHz Sweeping Function Generator **$1,850**
**Includes:** Instruction manual (070-2986-00).

**284**

**Pulse Generator**

**DD 501**




**Digital Delay**

# 284

**70 ps or Less Risetime Pulse**

**Sinewave and Squarewave Outputs**

## CHARACTERISTICS

**Pulse Output** — 70 ps or less risetime with a pulse width of more than 1 μs and a repetition rate of ≈50 kHz. Aberrations immediately following positive-going transitions are < ±3%, 3% total p-p; after 2 ns < ±2%, 2% total p-p. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

**Squarewave Output** — Periods of 10 μs, 1 μs, or 100 ns. Amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

**Sinewave Output** — Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

**Trigger Output** — Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When Pulse Output is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

| Output | Period | Timing Accuracy | Amplitude Accuracy 1 V | 100 mV | 10 mV |
|---|---|---|---|---|---|
| Pulse | 20 μs | ±10% | | | |
| Square-wave | 10 μs<br>1 μs | ±0.5% | ±0.5% | ±1% | ±1.5% |
| | 100 ns | ±0.05%*1 | ±2%*2 | ±2.5%*2 | ±3%*2 |
| Sinewave | 10 ns<br>1 ns | ±1% | | ±20% | |

*1 *Crystal controlled.*
*2 *20 ns after transition.*

The 284 is not part of the TM 500 Series, and does not require the use of a separate mainframe.

### ORDERING INFORMATION

**284** Pulse Generator **$2,310**
**Includes:** Instruction manual (070-0754-01).

# DD 501

**Digital Events Delay**

**Delay to 99,999 Events**

**Divide by N up to 20 MHz**

**Pulse Counting to 65 MHz**

**Time Delay with External Clock**

**Compatible with Most Attenuator Probes**

The DD 501 Digital Delay is an events-counting device which can be used with pulse, function and clock generators in such applications as precise digital delay between two related events, divide-by-N frequency divider, precision gate generator, counted burst output from a gated pulse or frequency generator, etc.

The DD 501 has basically two modes of operation. In the gating mode, the DD 501 generates a gate which starts with the application of a start pulse and continues until a selected number of event pulses have occurred. It can be used for generating a counted burst of N pulses when used with a pulse generator capable of being gated. Tektronix generators capable of being gated by the DD 501 are the FG 501A, FG 502, FG 504, FG 507, FG 5010, PG 507, and PG 508.

In the delayed trigger mode, the DD 501 generates a trigger pulse after the selected number of event pulses have occurred. Besides being used strictly for generating precision delays, the delayed trigger mode can also be used as a frequency count-down divider for any frequency up to 65 MHz. In both modes, the desired number of events (from 0 to 99,999) is selected by front-panel thumbwheel switches.

Trigger slope and level controls for both the Start and Events inputs permit use with a wide variety of applied signals. Both inputs are compatible with Tektronix attenuator probes. In special applications, the trigger levels may be remotely set by application of analog voltages through the front-panel Level In/Out jacks.

## CHARACTERISTICS

### EVENTS DELAY

**Count** — 10 to 99,999 events.

**Maximum Count Rate** — 65 MHz.

**Insertion Delay** — 30 ns or less from final event to trigger output pulse.

**Recycle Time** — 50 ns or less.

**Reset** — Manually resets delay counter.

### INPUT CHARACTERISTICS

(All characteristics apply to both events and start inputs).

**Input Impedance** — 1 MΩ, 20 pF.

**Slope** — Either + or −, selectable.

**Sensitivity** — 85 mV p-p at 30 MHz.

**Frequency Response** — Up to 65 MHz at 120 mV sensitivity.

**Minimum Detectable Pulse Width** — 5 ns,

**Threshold Level Range** — From −1.0 V to +1.0 V (−10 V to +10 V with 10X probe). Can be externally programmed or monitored at front panel jacks.

**Trigger View Out** — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).

**Events Triggered Light** — Visual indication that events are being detected.

**Start Triggered Light** — Visual indication that delay is in progress.

### TRIGGER OUTPUT

**Pulse Width** — Width of events pulse plus 6 ns or less.

**Voltage Swing** — +0.8 V or less to at least +2.0 V with 3 TTL loads (≈5 mA).

**Light** — Indicates output trigger.

### ORDERING INFORMATION

**DD 501** Digital Delay **$1,600**
**Includes:** Instruction manual (070-1818-01).





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## PRODUCT SUMMARY

Design engineers require power supplies that are flexible enough to meet their needs...and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench. To assure versatility and convenience in your test system, the TM 500 power supplies can be rear interfaced with other instruments to reduce front panel clutter while providing capabilities not otherwise available. For example, the output level can be monitored via the rear interface by a companion TM 500 digital multimeter without the need for extra cabling at the front of the instrument. Remote sensing terminals available at the rear panel allow sensing of the applied voltage at the load, thereby minimizing the effects of loading on the supply. In addition, the plus and minus floating outputs of the PS 503A can be programmed remotely, by either voltage programming or resistance programming, via the rear interface.

The PS 501-1 supplies 0 volt to 20 volt (floating) and adjustable current limiting to 400 milliamps, with constant current operation above the limit setting. A multiturn dial with mechanical digital readout provides accurate setting of the output voltage. The fixed 5 volt supply supplies up to 1 amp.

The PS 503A provides a floating dual −20 volt to 0 volt and 0 volt to +20 volt variable supply, plus the 5 volt 1 amp supply. The two variable supplies can be set individually and then varied in a tracked mode with a single control. By grounding one of the two outside terminals of the variable supply you can have a 0 volt to 40 volt supply with up to 1 amp of current when the PS 503A is operated in the high-power compartment of a TM 504, TM 506, RTM 506, or TM 5006. Full descriptions of the IEEE Standard 488 compatible PS 5004 and PS 5010 appear on pages 346 and 347.

## POWER SUPPLIES SELECTION GUIDE

| APPLICATION/FEATURE | PS 501-1 | | PS 503A | | PS 5004 | PS 5010 | |
|---|---|---|---|---|---|---|---|
| **Power Supplies** | **0 to 20 V** | **+5 V** | **+ and −20 V** | **+5 V** | **0 to 20 V** | **+ and −32 V** | **Logic** |
| **Floating** | 350 V (dc + peak ac) | Ground referenced | 350 V (dc + peak ac) | Ground referenced | 42 V (dc + peak ac) | 150 V peak front panel, 42 V peak rear interface | Ground referenced |
| **Voltage Range** | 0 to 20 V | 5 V | 0 to ±20 V | 5 V | 0 to 20 V | 0 to ±32 V | 4.5 to 5.5 V |
| **Current Range** | | | | | | | |
| **High Power Compartment** | 40 mA to 400 mA | 1 A | 100 mA to 1 A | 1 A | 0 to 300 mA | 50 mA to 0.760 A (1.6 A up to 15 V) | 100 mA to 3.0 A |
| **Standard Compartment** | | | 40 mA to 400 mA | | | 50 mA to 400 mA (0.750 A up to 15 V) | |
| **Voltage Mode Overall Accuracy (total effect)** | | | | | ±(0.01% +500 μV) | ±(0.5% +20 mA) | ±50 mV |
| **Accuracy** | 0.5% | | | | | | |
| **Source Effect (line regulation)** | 5 mV | 50 mV | 5 mV | 5 V ±0.25 V | 0.005% | ±(0.1% +2 mV) | 1 mV |
| **Load Effect (load regulation)** | 1 mV for a 400 mA change in load current | 100 mA for 1 A change in load current | 3 mV for 1A change in load current | 100 mV for 1 A change in load current | 500 μV for 300 mA change in load current | 10 mV for 1 A change in load current 1 mV using remote sensing | |
| **Temperature Coefficient** | Typically <0.01%/°C | | Typically <0.025%/°C | | ≤(30 ppm +100 μV/°C | Typically <(0.01% +0.1 mV)/°C | Typically <500 μV/°C |
| **Resolution (step size)** | 1.6 mV | | 50 mV | | 500 μV | 10 mV up to 10.0 V 100 mV above 10.1 V | 10 mV |
| **PARD (ripple and noise) (periodic and random deviations)** | 0.5 mV p-p 0.1 mV RMS | 5 mV p-p | 3 mV p-p | 5 mV p-p | ≤3 mV p-p | 10 mV p-p 1 mV RMS | 10 mV p-p 2 mV RMS |
| **Current Mode Overall Accuracy (total effect)** | Current limit | | Current limit | | Constant current 10 mA to 300 mA | Current limit with fold ±(5% +20 mA) | back ±(5% +20 mA) |
| **Source Effect (line regulation)** | | | | | | 1 mA | |
| **Load Effect (load regulation)** | | | | | | 10 mA | |
| **Temperature Coefficient** | | | | | | Typically <(0.1% +1 mA)/°C | |
| **Resolution (step size)** | | | | | 2.5 mA | 50 mA | 100 mA |
| **PARD (ripple and noise)** | | | | | | 10 mA p-p 5 mA RMS | |
| **Display** | | | | | | | |
| **Voltage** | 10 turn potentiometer with a three digit in-line dial and range pushbutton | None | Voltage indicatory lights. Brightness varies with output voltage | None | Five digit LED | Each supply as three digit LED display shared between voltage and current | |
| **Current** | LED indicator | None | Current limit indicator lights | None | | | |
| **Programmability** | Voltage programming | None | Voltage and resistance programming | None | IEEE Standard 488-1978 (GPIB) full listen and talk capability with interrupt status reporting | | |
| **Tracking** | | None | Ratio | None | None | Arithmetic | None |
| **Remote Sensing (rear interconnect)** | ✓ | | ✓ | | ✓ | ✓ | |
| **Output On/Off** | ✓ | | ✓ | | ✓ | ✓ | |
| **Mainframe Capability** | TM 500/TM 5000 | | TM 500/TM 5000 | | TM 5000 | TM 5000 | |
| **Page** | 376 | | 376 | | 346 | 347 | |
| **Prices** | $595 | | $750 | | $1,850 | $3,050 | |

**For recommended accessories see page 448.**

# PS 501-1

**Floating Output, 0 V to 20 V**

**0 mA to 400 mA**

**Precise Regulation**

**Low Ripple and Noise**

**Fixed Output + 5 V at 1 A**

**3½ Digit Ten Turn Dial**

The PS 501-1 features precise regulation and better than 2 mV resolution (setability) over a 0 V to 20 V range.

## CHARACTERISTICS

**Output** — 0 V to 20 V dc.

**Maximum Rated Current** — 400 mA to +30°C derating to 300 mA at +50°C.

**Accuracy** — ±(0.5% + 10 mV).

**Current Limit** — <40 mA to 400 mA.

**Line Regulation** — Within 5 mV for a +10% line voltage change.

**Load Regulation** — Within 1 mV for a 400 mA load change.

**Ripple and Noise** — 0.5 mV p-p or less; 20 Hz to 5 MHz.

**Temperature Coefficient** — Typically <(0.01% +0.1 mV)/°C.

**Minimum Resolution** — Typically 1.6 mV.

**Transient Recovery Time** — ≤20 μs to recover within 20 mV of final output voltage after a 400 mA change in output current.

## ORDERING INFORMATION

**PS 501-1** Power Supply **$595**

**Includes:** Instruction manual (070-1301-02).

# PS 503A

**Independent + and − Controls**

**Dual Tracking Voltage Control**

**0 V to ±20 V at 1 A (in High-Power Compartment)**

**Fixed Output + 5 V at 1 A**

**Remote Resistance Programming**

**Over-Voltage Protection Standard**

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 mainframe, the PS 503A provides up to 1 A from both 0 V to 20 V supplies.

## CHARACTERISTICS

### ±20 V FLOATING SUPPLIES

**Outputs** — 0 V to ±20 V dc with respect to the common terminal or 0 V to 40 V dc across the + and − terminals. Outputs can be varied independently or at a constant ratio.

**Maximum Rated Current** — 400 mA (1 A in high power compartment to +30°C derating to 300 mA (750 mA) at +50°C.

**Tracking Mode Offset Error** — If the two supplies are set independently to any given voltage ratio and then varied by use of the Volts Dual Tracking control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

**Current Limit** — Adjustable from <100 mA to 1 A (high-power compartment) or <40 mA to 400 mA (standard compartment) on each supply.

**Load Regulation** — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

**Ripple and Noise** — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

**Indicators** — Individual voltage indicators and current limiting indicators for both + and − supplies. Standard compartment (400 mA) indicator.

## ORDERING INFORMATION

**PS 503A** Power Supply **$750**

**Includes:** Instruction manual (070-1834-01).

### COMMON CHARACTERISTICS (PS 501-1, PS 503A) 20 V FLOATING SUPPLIES

**Primary Power Input** — Determined by mainframe (TM 501, TM 503, etc).

**Output** — Floating, isolated for 350 V dc + peak ac above ground.

**Stability** — Typically (0.1% +5 mV) or less drift in 8 hrs of constant line, load, and temperature.

**Indicator Lights** — Voltage variation and current limit.

### +5 V GROUND-REFERENCED SUPPLY

**Output** — 5 V nominal, ±0.25 V at 1 A.

**Load Regulation** — Within 100 mV with a 1 A load change.

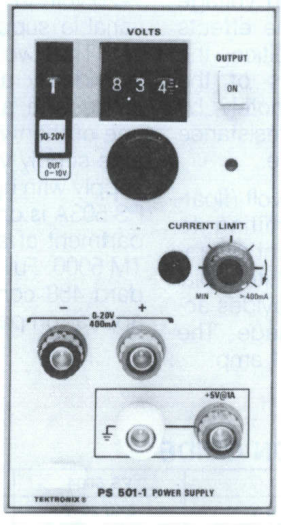
**Line Regulation** — Within 50 mV for a 10% line voltage change.

**Ripple and Noise (1A)** — 5 mV p-p or less, 20 Hz to 5 MHz.

**Stability** — Typically 30 mV or less drift in 8 hrs.

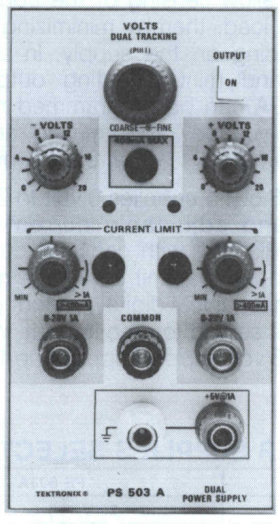
**Overload Protection** — Automatic current limiting and over-temperature shutdown.

PS 501-1



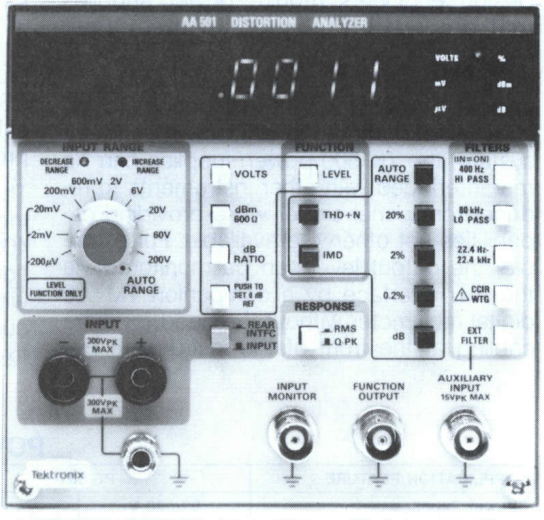

Power Supply

PS 503A




Triple Power Supply

AA 501 Option 02




Distortion Analyzer

# AA 501

**Fully Automatic: No Level Setting, Tuning or Nulling**

**Level, Total Harmonic Distortion, and dB Ratio Measurements**

**Total System Harmonic Distortion Plus Noise (THD+N) <0.0025%**

**≤3.0 μV Residual Noise**

**Digital Readout Plus Analog-Like "Bar Graph" for Peaking and Nulling**

**IMD to SMPTE, DIN, and CCIF (Option 01)**

The AA 501 Distortion Analyzer provides completely automatic measurement of level, total harmonic distortion plus noise (THD+N), and (with Option 01) Intermodulation Distortion. Automatic set level, automatic tuning, automatic nulling of the fundamental, and autoranging of the display all combine to permit completely hands-off operation once the mode is selected. Just apply the signal of interest and read the 3½-digit display. A novel analog-like bar graph simulates an analog meter to assist in peaking and nulling of applied signals.

With Option 01, intermodulation distortion measurements can be made to any of the three common standards: SMPTE, DIN, or CCIF. Internal circuitry automatically identifies the signal being used and selects the proper filtering circuits to perform the measurement.

DB ratio measurements may be referenced either to 774.6 millivolts (1 milliwatt in 600 ohms) or to a selected applied signal. The 0 dB reference memory remembers the selected level, and all subsequent measurements are referenced to that level.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

The AA 501 allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The fundamental frequency range is 10 Hz to 100 kHz, with harmonics measured out to 300 kHz.

Any one of four built-in frequency-weighting filters may be switched into the signal paths for preconditioning of the signal to be measured. Provision is also made to permit the use of a user-selected filter as well.

A dc level, which is a function of the display readout, is available at the rear panel of the AA 501.

An Input Monitor connector and a Function Output connector are provided to permit oscilloscope display of the input signal or the result of the filter in the THD+N measurement.

The Option 02 version of the AA 501 is especially designed for use in accordance with CCIR recommendation 468-2 and DIN 45405 (typically used in Europe). In the Option 02 version, the 30 kHz filter and the "A" weighting filter of the standard unit are replaced by a 22.4-Hz-to-22.4-kHz filter and a CCIR-weighting filter, respectively, and the average responding detection circuit is replaced by a quasi-peak detection circuit. The Option 02 also contains the intermod measurement capability of the Option 01.

The AA 501 Distortion Analyzer and the SG 505 Oscillator were designed to be used together as the heart of a state-of-the art audio analysis system. Used together, the two provide total system harmonic distortion of 0.0025% or less.

It should be noted that the automatic frequency tuning of the AA 501 does not depend upon the manual tuning of a companion oscillator. The AA 501 will automatically tune itself to its input signal whether the signal originates from an SG 505 alongside it in a TM 500 mainframe, or from some other signal source miles away.

## CHARACTERISTICS

The following characteristics are common to the standard AA 501, Option 01 and Option 02 unless otherwise noted:

### HARMONIC DISTORTION FUNCTION

**Fundamental Frequency Range** — 10 Hz to 100 kHz automatically tuned to input frequency.

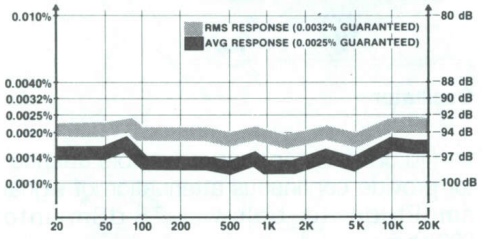
**Distortion Ranges** — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

**Accuracy (Readings ≥4% of Range)** — 20 Hz to 20 kHz ±1 dB, 10 Hz to 100 kHz +1, −3 dB. (Accuracy is limited by residual THD+N and filter selection.)

**THD** — Complete Automatic Total Harmonic Distortion (THD) measurements to specified accuracy in seven seconds or less.

**AA 501/SG 505 System Residual THD+N** — $V_{in}$ ≥250 mV, (all distortion, noise, and nulling error sources combined). 20 Hz to 20 kHz: ≤0.0025% (−92 dB) Average Response with 80 kHz filter (standard and Option 01 only). ≤0.0032% (−90 dB) RMS Response with 80 kHz filter. 10 Hz to 50 kHz: ≤0.0071% (−83 dB) RMS Response. 50 kHz to 100 kHz: ≤0.010% (−80 dB) RMS Response.

### TYPICAL THD+N




**Typical Fundamental Rejection** — At least 10 dB below specified residual THD+N or actual signal THD, whichever is greater.

**Minimum Input Level** — 60 mV (−22 dBm).

### NOISE (OPTION 02)

Noise measurements to CCIR recommendation 468-2 and DIN 45405. True RMS or quasi-peak response. Total system THD + N = 0.0032% (90 dB) RMS response. Balanced input.

### LEVEL FUNCTION

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

**Modes** — Volts, dBm (600 Ω), or dB ratio with push to set 0 dB reference.

**Level Ranges** — 200 μV full scale to 200 V full scale in ten steps, manual or autoranging.

**Accuracy*1**

| Frequency | Volts | dBm or dB Ratio |
|---|---|---|
| 20 Hz to 20 kHz | ±2% | ±0.3 dB |
| 10 Hz to 100 kHz*2 | ±4% | ±0.5 dB |

*1 *$V_{in}$ ≥ 100 μV, level ranging indicators extinguished.*
*2 *On the 200 μV range, accuracy above 50 kHz is +4%, −6% (+0.5 dB, −0.7 dB).*

**Bandwidth** — ≥300 kHz.

**Residual Noise** — ≤3.0 μV (−108 dBm) with 80 kHz and 400 Hz filters. ≤1.5 μV (−114 dBm) with "A" weighting filter.

### INTERMODULATION DISTORTION FUNCTION (OPTION 01/02)

Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.

**SMPTE and DIN Tests** — Lower Frequency Range: 50 Hz to 250 Hz. Upper Frequency Range: 3 kHz to 100 kHz. Level Ratio Range: 1:1 to 5:1 (lower:upper). Residual IMD: ≤0.0025% (−92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.

**CCIF Difference Frequency** — Frequency Range: 4 kHz to 100 kHz. Difference Frequency Range: 50 Hz to 1 kHz. Residual IMD: ≤0.0018% (−95 dB) with 14 kHz and 15 kHz. Minimum Input Level: 60 mV (−22 dBm).

**Accuracy** — ±1 dB.

### ALL FUNCTIONS

**Detection** — Average or true RMS for waveforms with crest factors ≤3.

**Filters**

400 Hz High Pass: −3 dB at 400 Hz ±5%; at least −40 dB rejection at 60 Hz.
80 kHz Low Pass: −3 dB at 80 kHz ±5%.
30 kHz Low Pass: −3 dB at 30 kHz ±5% (standard and Option 01 only). "A" Weighting: Meets specifications for Type 1 sound level meters (ANSI S 1.4, IEC Recommendation 179) (standard and Option 01 only). Ext: Allows connection of external filters. 22.4 Hz to 22.4 kHz: −3 dB ±5% (Option 02 only). CCIR WTG: CCIR Recommendation 468-2 and DIN 45405, functional only with Q-PK detector (Option 02 only).

**Input Impedance** — 100 kΩ ±2%, each side to ground, fully differential.

**Maximum Input** — 300 V peak, 200 V RMS either side to ground or differentially. Fully protected on all ranges.

**Common Mode Rejection** — ≥50 dB at 50 Hz or 60 Hz. Typically ≥40 dB to 300 kHz.

### FRONT PANEL SIGNALS

**Input Monitor** — Provides constant amplitude version of signal applied to input. Output Voltage: 1 V RMS ±10% for input signals >50 mV. Source Impedance: 1 kΩ ±5%.

**Function Output** — Provides a scaled sample of selected function signal (1000 count display = 1 V RMS ±3%). Source Impedance: 1 kΩ ±5%.

**Auxiliary Input** — Provides input to detector circuit when Ext Filter button is depressed. Sensitivity: 1 V RMS ±3% = 1000 count display. Impedance: 100 kΩ ±5%, ac coupled.

### REAR INTERFACE SIGNALS

**Rear INTFC Input** — Front panel selected. Same as main Input except, maximum signal input is limited to 42 V peak, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion on performance).

**Monitor** — Same as front panel Input Monitor.

**Function Output** — Same as front panel Function Output.

**Auxiliary Input** — Same as front panel Auxiliary Input.

**Converter Output** — Dc output of selected response converter. 1 V ±5% for 1000 count display. Source Z: 500 Ω ±5%.

**dB Output** — Dc output of logarithmic dB converter. 10 mV ±5% per 1 dB of display. Source Z: 1 kΩ ±5%.

## ORDERING INFORMATION

**AA 501** Distortion Analyzer **$2,525**

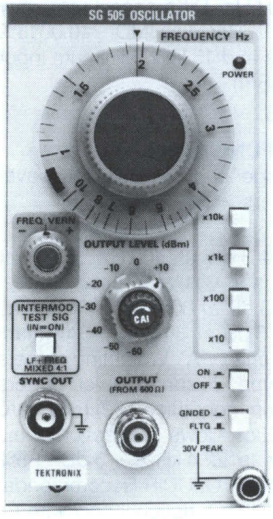
**Includes:** Instruction manual (070-2958-00).

**OPTIONS**

**Option 01** — Intermodulation Distortion. **+$750**

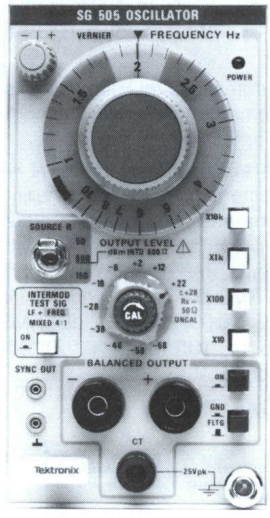
**Option 02** — CCIR/DIN (Includes Option 01). **+$1,150**

**SG 505 Option 01**




**Oscillator**

**SG 505 Option 02**




**Oscillator**

# SG 505/Option 01/Option 02

**10 Hz to 100 kHz Sinewave Output**

**Ultra-Low Distortion: <0.0008% THD (Typically 0.0003%)**

**Floating or Grounded Output**

**600 Ohm Source Impedance**

**Vernier Frequency Control**

**Fully Balanced Output (Option 02)**

**Calibrated Output to +28 dBm (Option 02)**

**Selectable Source Impedance (Option 02)**

**Intermodulation Test Signal (Option 01 & 02)**

The SG 505 Oscillator generates an ultra-low distortion sinewave over the frequency range from 10 Hz to 100 kHz (<0.0008% THD, typically 0.0003% between 20 Hz and 20 kHz). In the standard and Option 01 units the output can be floated or referenced to chassis ground. In the Option 02 unit, the output is fully balanced and floating with a center tap which may be attached to system ground or to either side of the output signal. The oscillator also provides a fixed amplitude ground referenced sinewave at the Sync Out connector, which is identical in frequency to the signal from the Output connector.

Option 01 adds an intermodulation test signal function. This signal consists of a selectable 60 Hz or 250 Hz mixed with the selected frequency in a 4:1 amplitude ratio.

For communications and broadcast applications, the Option 02 provides a fully balanced output of +28 dBm into 600 ohms from 50 ohms. A ten-position step attenuator (10 dB per step) and a variable attenuator provide continuous attenuation of signal amplitude to below −78 dBm into 600 ohms.

A front panel switch allows the selection of three different source resistances: 50 ohms for low impedance applications (improves measurement accuracies on long cable runs and reduces loading effects), 150 ohms for matching microphone circuits, and 600 ohms for complying with audio/ communication industry standard and general purpose applications.

Option 02 also includes the intermodulation test signal capability of the Option 01.

## CHARACTERISTICS

### MAIN OUTPUT

The following characteristics are common to the standard SG 505 and Option 01.

**Frequency Range** — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least ±1% of frequency setting.

**Calibrated Output** — Selectable from +10 dBm to −60 dBm into 600 Ω in eight 10 dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to <−10 dB from calibrated positon.

**Amplitude Response** — Level flatness ±0.1 dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding >50 kHz on −60 dB output level range).

**Harmonic Distortion** — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0032% (−90 dB) THD from 50 kHz to 100 kHz ($R_L$ ≥600 Ω).

**Output Impedance** — 600 Ω ±2%; floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Maximum floating voltage ±30 V peak.

**Maximum Output Voltage** — At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or +12.2 dBm) into 600 Ω.

### SYNC OUTPUT

**Signal** — 200 mV RMS ±20% sinewave to 20 kHz, at least 120 mV RMS at 100 kHz.

**Frequency** — Same as main output.

**Impedance** — Nominally 1 kΩ, ground referenced and isolated from main output.

### REAR INTERFACE SIGNALS

**Buffered Main Output** — Buffered version of actual output signals from front panel connector. ≈300 Ω Output impedance.

**Sync Output** — Same as front panel Sync Output except output impedance is ≈50 Ω.

## Option 01 IM Test Signal

Selecting the IM Test Signal causes a LF sinewave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

**LF Frequency** — Internally selectable 60 Hz (±1 Hz) or 250 Hz (±3 Hz).

**Main Output** — Composite p-p output within 0.2 dB of normal oscillator mode output.

**Residual IMD** — Typically <0.0005% from 2.5 kHz to 10 kHz.

**Sync Output** — LF signal component only, 200 mV RMS ±20%.

## Option 02 Oscillator

### MAIN OUTPUT

**Calibrated Output** — Selectable from +22 dBm to −68 dBm into 600 Ω in ten 10 dB steps. Accurate to within 0.2 dB at +22 dBm and 1 kHz. Step accuracy is ±0.1 dB/10 dB step or 20 dB step change. An uncalibrated control provides continuous variation from <−10 dB to +0.3 dB from calibrated position.

**Harmonic Distortion** — <0.0008% (−102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (−95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0056% (−85 dB) THD from 50 kHz to 100 kHz ($R_L$ ≥600 Ω).

**Output Impedance** — Selectable 600 Ω ±2%, 150 Ω ±2% or 50 Ω ±3% floating or grounded through ≈30 Ω. Output impedance does not change with Output On/Off selection. Impedance to CT is ½ the selected impedance. Maximum floating voltage ±25 V peak.

**Maximum Output Voltage** — At least 21 V RMS open circuit; 19.45 V RMS (+28 dBm) into 600 Ω from 50 Ω.

**Balance** — ≤0.5% mismatch of output open-circuit voltages referenced to CT for f ≤20 kHz with output grounded.

## ORDERING INFORMATION

| | |
|---|---|
| **SG 505** Oscillator | **$875** |
| **Includes:** Cable assembly for sync output (175-1178-00); instruction manual (070-2823-00). | |
| **Option 01** — IM Test Signal. | **+$220** |
| **Option 02** — Oscillator (Includes Option 01). | **+$715** |





**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

## PRODUCT SUMMARY

The TM 500 Signal Conditioners offer unique capabilities for solving electrical measurement and analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups, within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs including: preamplification of low level signals, addition or removal of dc offset, integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V peak-to-peak).

The AM 503 is specifically designed to work with the A6303/A6302 Current Probes (dc to 50 MHz), and incorporates a feature that limits the bandwidth to 5 MHz, to eliminate transients or noise. An illuminated knob skirt indicates calibrated current per division.

The A6302/AM 503 and A6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. These probes use inductive coupling to minimize interference with the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset and low-frequency and high-frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to 1 V. High performance features of the AM 502 are a dc to 1 MHz bandwidth and 100 dB common-mode rejection ratio.

The AM 501 Operational Amplifier's output power (±40 V and ±50 mA across 800 Ω loads) is more than adequate for most electronic and electro-mechanical applications. This high-output unit has front panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentation, integration, summing and impedance transformation problems.

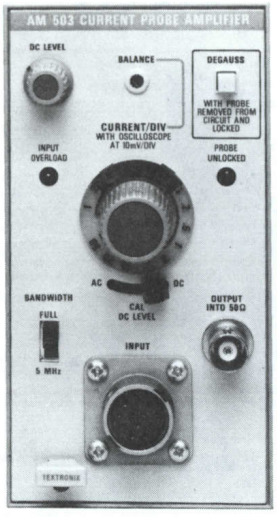
# AM 503

**Displays Current Signals on an Oscilloscope**

**Current Range, Maximum Current, and Bandwidth Determined by the Probe Used**

The AM 503 Current Probe Amplifier allows display of current on any oscilloscope with 10 mV/div sensitivity, 50 Ω or 1 MΩ input, and (for performance to full bandwidth specifications) at least 75 MHz when using the A6302 or 50 MHz when using the A6303. The amplifier attenuator is calibrated in 12 steps with a 1-2-5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to Full (where it is limited by the probe in use) or to 5 MHz. Coupling may be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.

**AM 503**




**Current Probe Amplifier**

## CHARACTERISTICS

The AM 503 characteristics when used with the A6302 or A6303 Current Probes.

**Maximum Input Current —** 20 A (dc + peak ac) for A6302. 100 A (dc + peak ac) for A6303.

**Maximum Voltage for Current Under Test (Bare Conductor) —** 500 V (dc + peak ac) for A6302. 700 V (dc + peak ac) for A6303.

**Bandwidth (−3 dB) —** Dc to at least 50 MHz with A6302. Dc to at least 15 MHz with A6303.

**Risetime (Full Bandwidth) —** 7 ns or less with A6302. 23 ns or less with A6303.

**Deflection Factor —** 1 mA/div to 5 A/div for A6302. 20 mA/div to 50 A/div for A6303. In a 1-2-5 sequence for both probes.

**Attenuator Accuracy —** Within 3% of indicated Current/Div for both probes.

### ORDERING INFORMATION

**AM 503** Current Probe Amplifier **$1,125**

**Includes:** 50 Ω cable with BNC (012-0057-01); 50 Ω terminator (011-0049-01); instruction manual (070-2052-01).

**A6303**

# A6303 Current Probe

**Ac and Dc Current Measurements to 100 A**

**Dc to 15 MHz Bandwidth**

**Peak Pulse Measurements to 500 A**

**Ac or Dc Coupling**

**One Inch by 0.830 Inch Jaw Opening**

**One-Hand Operation**

This clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the A6303 can easily be clamped to cables up to 0.830 inch. Other measurement parameters of the probe include: 100 A continuous and 500 A peak.

By combining an oscilloscope, like the SC 504, with the A6303/AM 503 Current Probe Amplifier in a TM 500/TM 5000 mainframe you will have a convenient and compact high current amplification/measurement system.

### ORDERING INFORMATION

**A6303** Current Probe **$1,070**

**Includes:** Carrying case (016-0622-00); instruction manual (070-3906-01).

# A6302 Current Probe

**1 mA to 20 A Current Measurement Range**

**50 A Peak Pulse Measurements**

**Dc to 50 MHz Bandwidth**

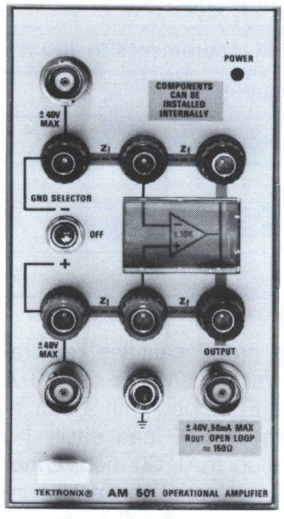
When a A6302 Current Probe is used with the AM 503 Current Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A, not to exceed a product of 100 A μs. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

### ORDERING INFORMATION

**A6302** Current Probe **$565**

**Includes:** Five inch ground lead (175-0124-01); three inch ground lead (175-0263-01); two alligator clips (344-0046-00); instruction manual (070-3905-01).

**AM 501**




**Operational Amplifier**

# AM 501

**±40 V, 50 mA Output**

**Open Loop Gain 10,000**

**50 V/μs Slew Rate**

**Symmetrical Differential Design**

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 modules. Components may be added externally or internally making it ideal for teaching operational amplifier theory.

## CHARACTERISTICS

### AMPLIFIER

**Open Loop Gain** — At least 10,000 at 60 Hz into 800 Ω load.

**Unity Gain Bandwidth** — At least 5 MHz into 800 Ω load.

**Common-Mode Rejection Ratio** — Typically >20,000 to 1 at 60 Hz for common-mode signals up to ±40 V.

**Slew Rate** — At least 50 V/μs into an 800 Ω load.

### INPUT

**Input Bias Current** — Typically <500 pA at 25°C, <2 nA at 50°C.

**Drift** — <100 μV/°C.

**Noise** — <10 μV RMS.

**Maximum Differential Input Voltage** — 80 V.

### OUTPUT

**Voltage Range** — At least ±40 V into 2 kΩ.

**Current Limit** — At least ±50 mA.

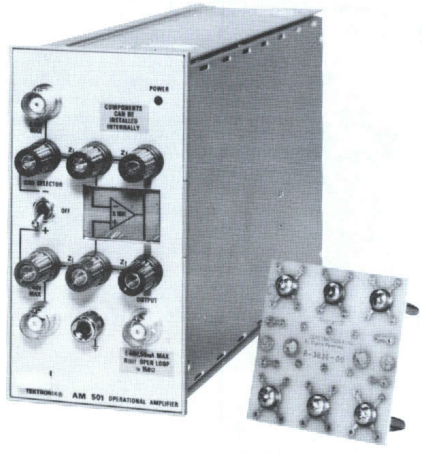
**Open Loop Output R** — ≈150 Ω.

## ORDERING INFORMATION

**AM 501** Operational Amplifier **$695**

**Includes:** Instruction manual (070-1616-01).

**AM 501 Accessory**



**Auxiliary Circuit Board Kit**

The Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is a pc board that has six terminal studs for attachment to the amplifier's banana jacks and is approximately 2.5 inches square. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier and does not interfere with the other connectors on the face of the AM 501.

## ORDERING INFORMATION

**Auxiliary Circuit Board Kit**
Order 013-0146-00 **$22**

# AM 502

**1 to 100,000 Gain**

**100 dB CMRR**

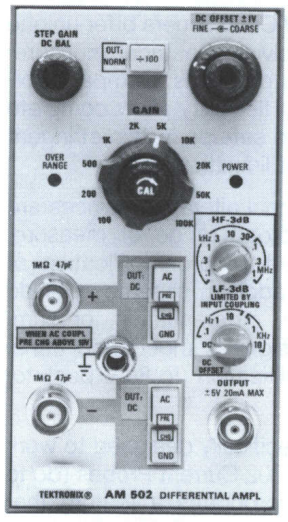
**Selectable Upper and Lower −3 dB Points**

**Dc to 1 MHz Maximum Bandwith**

**Adjustable Dc Offset**

The AM 502 Differential Amplifier features wide bandwidth, high CMRR, and selectable calibrated gain and filtering. Well-suited for general purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

**AM 502**




**Differential Amplifier**

## CHARACTERISTICS

### AMPLIFIER

**Gain** — 100 to 100,000; 1-2-5 sequence; accurate within 2%. 1X gain obtained by 100X attenuation.

**HF −3 dB POINT** — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. Upper −3 dB point reduces to 500 kHz at 50 k gain; 250 kHz at 100 k gain.

**LF −3 dB POINT** — Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits −3 dB point to 2 Hz or less.

**Variable Dc Offset** — At least ±1 V.

**Common-Mode Rejection Ratio** — Normal Mode: At least 100 dB, dc to 50 kHz. ÷ 100 Mode: At least 50 dB, dc to 50 kHz.

### INPUT

**Input Gate Current** — ±100 pA for T ≤30°C.

**Maximum Voltage Drift** — 100 μV/°C referred to input Normal mode.

**Maximum Noise** — ≤25 μV or less (tangentially measured) referred to input Normal mode.

**Maximum Input Voltage** — Normal Mode Dc Coupled: 15 V (dc + peak ac). ÷ 100 Mode Dc Coupled: 350 V (dc + peak ac). Ac Coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

**Input R and C** — 1 MΩ paralleled by ≈47 pF. Input impedance can be increased to a FET input via a simple internal jumper change.

### OUTPUT

**Maximum Output** — ±5 V, ±20 mA, output resistance is 5 Ω or less.

**Minimum Load Impedance** — 250 Ω

**Over Range** — Front-panel lamp indicates most over-range conditions.

## ORDERING INFORMATION

**AM 502** Differential Amplifier **$1,400**

**Includes:** Instruction manual (070-1582-01).

Compatible accessories begin on page 426.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## PRODUCT SUMMARY

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronics test and measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop the TM 500 line of modular instrumentation without including CRT display capability.

Four choices of performance level and display size are available to add waveform display to the digital measurement capability of the TM 500 digital multimeters and counters, ranging from the high-performance, dual-trace, 80 MHz SC 504 to the single-trace, single-width, 5 MHz SC 501. The 15 MHz SC 502 adds moderate dual-trace performance to the line, and the 10 MHz, dual-trace SC 503 adds CRT storage capability.

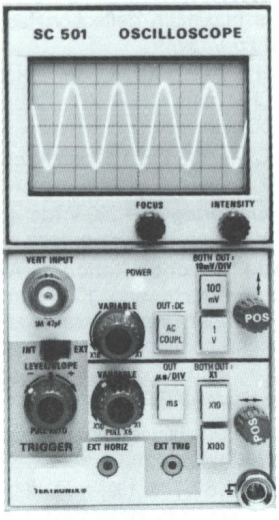
All of the oscilloscopes feature automatic triggering, and the SC 504, SC 503, and SC 502 also provide trigger view and variable trigger holdoff. All of the oscilloscopes have provisions to permit instrument-to-instrument rear interfacing within a mainframe and to external devices of a test system.

With a compact TM 500 oscilloscope and a multi-compartment TM 500 mainframe, it is now possible to carry an oscilloscope and companion instruments to and from a test site in one convenient package.

### TM 500 OSCILLOSCOPE SELECTION GUIDE

| FEATURE | SC 504 | SC 503 | SC 502 | SC 501 |
|---|---|---|---|---|
| Number of Channels | 2 | 2 | 2 | 1 |
| Bandwidth (MHz) | 80 | 10 | 15 | 5 |
| Highest Sensitivity (mV/Div) | 5 | 1 | 1 | 10 |
| Fastest Sweep Rate (ns/Div) | 5 | 50 | 20 | 200 |
| Storage | No | Yes | No | No |
| Page | 382 | 383 | 384 | 381 |
| Prices | $3,895 | $4,095 | $2,795 | $1,495 |

**SC 501**




**5 MHz Oscilloscope**

# SC 501

**5 MHz Bandwidth**

**Single Compartment Size**

**6.4 cm (2.5 in) CRT**

**Versatile Operating Features**

The SC 501 is a single-channel, 5 MHz plug-in unit oscilloscope with a 2.5 inch CRT display that occupies a single TM 500 Series plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500 Series test and measurement instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500 Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 or TM 5000 mainframe, it can be used on the bench, in a rack, or on the road. The single-channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by push-button logic in decade steps from 1 μs/div to 100 ms/div. A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 V to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions, for example sweeping a voltage-controlled frequency oscillator.

The triggering circuits allow stable triggering from either internal or external sources. An Autotriggering mode and manual Level/Slope selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

For X-Y operation an internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth** — Dc to >5 MHz.

**Deflection Factors** — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated: Variable is continuous between steps (10:1) and to at least 10 V/div.

**Input Coupling** — Ac or dc.

**Input Impedance** — 1 MΩ paralleled by 47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

### HORIZONTAL DEFLECTION

**Time Base** — Calibrated Sweep Rates: 1 μs/div to 100 ms/div in decade steps. Uncalibrated (Variable) Range: Extends slowest calibrated rate to ≥1 s/div. X5 Magnifier (Fixed): Extends fastest calibrated sweep rate to 200 ns/div. Accuracy (over center eight division): g5% for all sweep rates. Linearity (any two division portion within center eight division): ≥5%.

**External Horizontal Amplifier** — Bandwidth: Dc to 100 kHz. Input Impedance: ≥100 kΩ paralleled by 25 pF. Maximum Input Voltage: ±3 V.

### TRIGGER

**Normal Trigger Sensitivity (Trigger Level/Slope In)** — Internal: Dc coupled, 0.4 major div of deflection at dc; increasing to 1.0 major div of deflection at 5 MHz. External: Dc coupled, 1 V minimum to 5 V maximum from dc to 5 MHz. External Trigger Input Impedance: 22 kΩ paralleled by ≈150 pF.

**Auto (Trigger Level/Slope Out)** — Sweep free-runs without trigger signal, or for trigger repetition rates below 10 Hz.

### CRT

**Phosphor** — GH (P31) is standard.

**Graticule** — 6 x 10 div (0.203 in/div).

## ORDERING INFORMATION

**SC 501** 5 MHz Oscilloscope **$1,495**

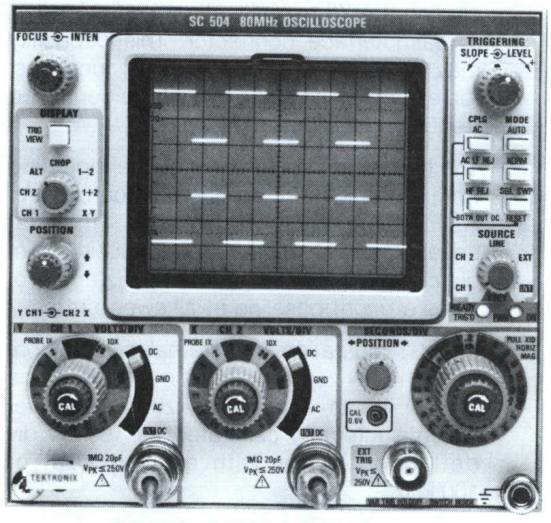
**Includes:** Instruction manual (070-1700-01).

**RECOMMENDED PROBES**

P6101A 1X, P6102A 10X, P6062B 1X/10X. See pages 430 and 432.

Compatible accessories begin on page 426.

**SC 504**




**80 MHz Oscilloscope**

# SC 504

**80 MHz Bandwidth**

**5 mV/div Maximum Sensitivity**

**5 ns/div Maximum Calibrated Sweep Rate**

**Enhanced Automatic Triggering**

**True X-Y Capability**

**Switchable Rear Interface Capability**

The SC 504 is a general purpose, dual-trace, non-delayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH 1 plus CH 2), differential (CH 1 minus CH 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable CH 1, CH 2 and ext trig inputs). Enhanced autotriggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use. The Tektronix P6108, P6122 and P6062B probes are recommended for use with the SC 504.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at −3 dB Points** — Dc to at least 80 MHz from 0°C to +35°C; dc to at least 70 MHz from +35°C to +50°C.

**Risetime** — 4.4 ns or less from 0°C to +35°C; 5 ns or less from +35°C to +50°C.

**Ac Low Frequency Response (Lower −3 dB Points)** — Without probe, 10 Hz; with 10X probe, 1 Hz.

**Deflection Factors** — Calibrated Range: 5 mV to 10 V/div, 11 steps in a 1-2-5 sequence.

**Accuracy** — ±2%, +15°C to +35°C; ±3%, 0°C to +50°C.

Uncalibrated: Variable is continuous between calibrated steps. At least 2.5:1 range. Extends maximum deflection factors to at least 25 V/div.

**Modes** — CH 1, CH 2, Alt., Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

**Input R and C** — 1 MΩ ±1% paralleled by ≈20 pF.

**Maximum Input Voltage** — 250 V (dc + peak ac), 500 V p-p ac at 1 kHz or less.

**Common-Mode Rejection Ratios** — At least 50:1 up to 1 MHz, and 10:1 from 1 MHz to 10 MHz when using the same attenuator settings; common-mode signal 5 div or less.

**Position Range** — ±6 div.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Calibrator** — 0.6 V, ±1%, ≈1 kHz frequency.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates of 5 ns/div. Uncalibrated (Variable) Range: The Cal (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 0.5 s/div.

**Sweep Rate Accuracy** — Measured over center 8 divisions, excluding first 50 ns and all after the first 100 divisions of magnified sweep. Derate accuracies by an additional 1% from 0°C to +15°C, +35°C to +50°C.

| +15°C to +35°C | X1 | X10 |
|---|---|---|
| 20 ms/div to 0.2 μs/div | ±2% | ±3% |
| 0.2 s/div to 50 ms/div | ±3% | ±4% |
| 0.1 μs/div to 50 ns/div | ±3% | ±4% |

**X-Y Mode** — Bandwidth: Dc to at least 2 MHz. Deflection factor, selected by CH 2 controls and horizontal mag X1, X10 with 5% accuracy. X and Y amplifier phase difference, less than 3° at 50 kHz or less. Input parameters same as CH 2.

### TRIGGER

**Trigger Modes** — Auto, Norm, and Sgl Swp.

**Enhanced Auto Trigger** — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, Line, Ext, Int.

**Trigger Coupling** — Ac, ac LF Rej, ac HF Rej, dc.

**Trigger Sensitivity** — Minimum p-p signal required.

| Coupling | Source | Dc to 30 MHz | 30 MHz to 80 MHz |
|---|---|---|---|
| Dc | CH 1, CH 2<br>External<br>Interface | 0.4 div 60 mV<br>Typically<br>50 mV | 1.0 div 150 mV<br>Typically 100 mV<br>to 50 MHz |
| Ac | Requirements increase below ≈50 kHz | | |
| Ac LF Rej | Requirements increase below ≈10 kHz | | |
| HF Rej | Requirements increase above ≈50 kHz | | |

**External Triggering Level Range** — ⩾ ±1.4 V.

**External Triggering Input** — Input R and C: 1 MΩ ±10% paralleled by approximately 24 pF. Maximum Input Voltage: 250 V (dc + peak ac); 250 V p-p at 1 kHz or less.

**Auto Mode** — Sweep free runs in the absence of a triggering signal. Trigger Level range is reduced to approximately the p-p range of the triggering signal.

**Single Sweep** — Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only.

**Trigger Holdoff** — At least 20 to 1 range. The variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

### CRT

**Phosphor** — GH (P31) is standard.

**Acceleration Potential** — ≈12 kV.

**Graticule** — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

### REAR INTERFACE

**CH 1 and CH 2 Vertical Inputs** — Selected by CH 1 and CH 2 coupling in Int (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

**Trigger Input** — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈40 pF.

**Z-Axis Input** — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, −5 V turns beam Off from On condition.

**Channel 1 Output** — At least 50 mV/div. Bandwidth: At least 30 MHz. Output Impedance: <50 Ω.

**Ramp Output** — 0 V to +10 V ramp. Output resistance ≈500 Ω.

## ORDERING INFORMATION

**SC 504** 80 MHz Oscilloscope **$3,895**

**Includes:** Instruction manual (070-2296-00).

For Floating Measurements, order A6902A Isolator.
See page 436 for complete description.

**RECOMMENDED PROBES**

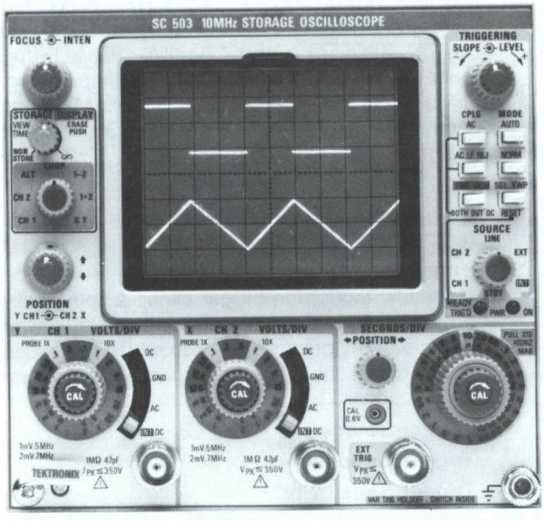
P6101A 1X, P6102A 10X, P6062B 1X/10X. See pages 430 and 432.

Compatible accessories begin on page 403.



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

**SC 503**




**10 MHz Dual Trace Storage Oscilloscope**

# SC 503

**10 MHz Bandwidth, Dual Trace**

**50 ns/div Maximum Calibrated Sweep Rate**

**1 mV/div Maximum Sensitivity**

**Bistable Storage Autoerase**

**Trigger View**

**Variable Trigger Holdoff**

**Switchable Front/Rear X and Y Inputs**

**Rear Z-Axis Input**

**True X-Y Capability**

The SC 503 is a nondelayed sweep, general purpose storage oscilloscope which can be used to store and display waveforms after the input signal is removed. This feature is particularly useful when measuring slow repetition rates or single-shot signals, important in the biomedical and mechanical measurements fields. Low frequency signals at heart or respiration rates can be stored for detailed analysis. In the mechanical measurements field the SC 503 can "freeze" fast or transient signals from transducers, which is especially useful in pressure-and velocity-versus-time analysis and shock testing.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

The SC 503 also features an auto-erase mode that erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including: acoustic speech testing, nerve potential testing, and optical stimulus response testing. The Tektronix P6108 and P6062B probes are recommended for use with the SC 503.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at −3 dB Points** — Dc to at least 10 MHz, (5 mV/div to 20 mV/div); dc to at least 7 MHz (2 mV/div), dc to at least 5 MHz (1 mV/div).

**Risetime** — 5 mV to 20 V/div, typically 35 ns or less.

**Ac Low-Frequency Response (Lower −3 dB Points)** — Without probe, 10 Hz; with 10X probe 1 Hz.

**Deflection Factors** — Calibrated Range: 1 mV/div to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) ±3%, 1 mV/div and 2 mV/div ±5%; (derate accuracy by additional 1% for 0°C to +50°C). Uncalibrated: Variable is continuous between steps to at least 2.5:1. Extends maximum uncalibrated deflection factor to at least 50 V/division.

**Modes** — CH 1, CH 2, Alt, Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

**Input Impedance** — 1 MΩ ±1% paralleled by ≈47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac), 700 V p-p ac at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.

**Common-Mode Rejection Ratio** — At least 50:1 at 1 MHz when using same attenuator setting, in CH 1 minus CH 2 mode.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Calibrator** — 0.6 V, ±1%, ≈1 kHz frequency.

**Position Range** — ±6 div.

**Channel Isolation** — 2% or less display related crosstalk to 10 MHz.

**Displayed Noise** — <0.2 mV p-p at 1 mV/div.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 2 s/div to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 50 ns/div. Uncalibrated (variable) range provides continuously variable sweep rates, between the calibrated rates, and extends the slowest rate of at least 5 s/div.

**Sweep Rate Accuracy*1**

| +15°C to +35°C | X1 | X10 |
|---|---|---|
| 2 s/div to 0.5 s/div | ±4% | ±5% |
| 0.2 s/div to 5 μs/div | ±3% | ±4% |
| 2 μs/div to 0.5 μs/div | ±4% | ±5% |

*1 *Derate accuracy by an additional 1% from 0°C to +15°C, +35°C to +50°C.*

**X-Y Mode** — Bandwidth: Dc to at least 500 kHz. Deflection Factor: Selected by CH 2 controls and Horizontal Mag X1, X10. Phase Difference: <3° at 50 kHz or less.

### TRIGGER

**Trigger Modes** — Auto (enhanced), Norm, and Sgl Swp (single sweep).

**Enhanced Auto Trigger** — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, Line, Ext, Int (rear interface).

**Trigger Coupling** — Dc, ac, ac LF Rej.

**Trigger Sensitivity*1** — Minimum p-p signal required.

| Source | dc to 5 MHz | 5 MHz to 10 MHz |
|---|---|---|
| CH 1, CH 2 | 0.4 div | 1.0 div |
| External | 60 mV | 150 mV |
| Interface | Typically 35 mV | Typically 80 mV |

*1 *With ac coupling requirements increase below ≈50 Hz. With ac LF Rej coupling requirements increase below ≈10 kHz.*

**Triggering Level Range** — External: At least ±1.2 V. Internal: At least −6.0 div.

**External Triggering Input** — Input Impedance: 1 MΩ, paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac), 350 V p-p at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz.

**Auto Mode** — Sweep free-runs in the absence of a triggering signal. Level control range automatically varies with the triggering signal amplitude for frequencies above 100 Hz.

**Single Sweep** — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only.

**Trigger Holdoff** — At least 20 to 1 range. The variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

### STORAGE SYSTEM

**Stored Writing Speed (Center 6 x 8 Divisions)** — At least 80 div/ms (50 cm/ms).

**Erase Time** — 400 ms to 600 ms.

**Autoerase Viewing Time** — Continuously variable from ≤0.5 s to ≥5 s.

**Maximum Recommended Storage Time** — ≈4 hrs.

### CRT

**Phosphor** — GX (P44).

**CRT Graticule** — 8 x 10 div., 0.25 in/div (0.64 cm/div). Internal graticule lines.

### REAR INTERFACE

**Channel 1 and Channel 2 Vertical Inputs** — Selected by CH 1 and CH 2 coupling in Int (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈100 pF.

**Trigger Input** — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω, when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

**Z-Axis Input** — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, −5 V turns beam Off from On condition.

**Channel 1 Output** — At least 50 mV/div. Bandwidth: At least 4 MHz. Output Impedance: 50 Ω.

**Ramp Output** — 0 V to +10 V ramp Output impedance ≈500 Ω.

## ORDERING INFORMATION

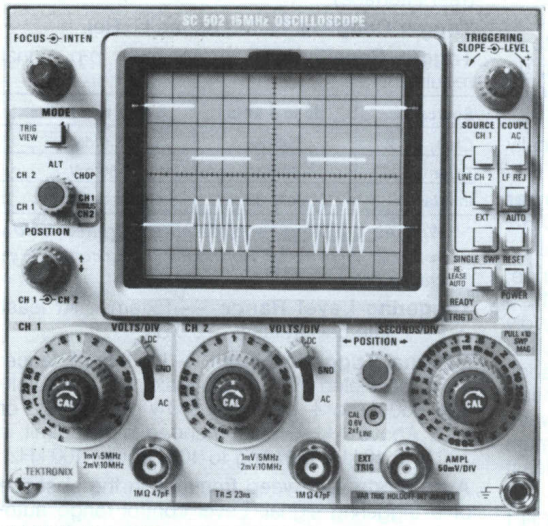
**SC 503** 10 MHz Storage Oscilloscope **$4,095**
**Includes:** Instruction manual (070-3438-00).

**RECOMMENDED PROBES**

P6101A 1X, P6102A 10X, P6062B 1X/10X. See pages 430 and 432.

Compatible accessories begin on page 403.

**SC 502**




**15 MHz Dual-Trace Oscilloscope**

# SC 502

**15 MHz Bandwidth, Dual Trace**

**20 ns/div Maximum Calibrated Sweep Rate**

**1 mV/div Maximum Sensitivity**

**Delay Line**

**Trigger View**

**Variable Trigger Hold-off**

**Enhanced Automatic Triggering**

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope designed to operate in any two adjacent compartments of a TM 500 power module/mainframe. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.

As with many Tektronix products, the SC 502 features circuits, subcircuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disk memories, key-to-tape, printers, plotters, punches, readers, and terminals. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.

The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interfacing capability of the SC 502 and all TM 500 instrumentation suggests exceptional applicability to systems of built-in test equipment or rackmounted installations. The TM 515 Traveler mainframe with the SC 502, forms a nucleus for sophisticated, compact field service "packages." The Tektronix P6062B and P6108 are recommended for use with the SC 502.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at −3 dB Points** — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

**Risetime** — 5 mV to 20 V/div, 23 ns or less.

**Ac Low-Frequency Response (Lower −3 dB Points)** — Without probe, 10 Hz; with probe (10X), 1 Hz.

**Deflection Factors** — Calibrated Range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0°C to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (Variable) Range: At least 2.5:1. Continuously Variable Between Calibrated Steps: Extends maximum attenuator step to at least 50 V/div.

**Modes** — CH 1, CH 2, Alt, Chop, CH 1 Minus CH 2. Chop rate at least 250 kHz. Triggering waveform is displayed instead of selected display when desired.

**Input Impedance** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac), 700 V p-p at ac 1 kHz or less.

**Common-Mode Rejection Ratio (CH 1 Minus CH 2 Mode)** — At least 50:1 at 1 MHz when using same attenuator setting.

**Channel Isolation** — 2% or less display related crosstalk to 15 MHz.

**Displayed Noise** — ≤0.2 mV p-p at 1 mV/div.

**Position Range** — ±6 div.

**Calibrator** — Voltage, 0.6 V ±1%. Frequency, twice the power line frequency.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (Variable) Range: The Cal (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

**Sweep Rate Accuracy** — Within 3% unmagnified, 4% magnified, +15°C to +35°C. Derated by an additional 1% for 0°C to +15°C and +35°C to +50°C.

**External Horizontal Amplifier** — Bandwidth: Dc coupled, dc to at least 2 MHz; ac coupled <50 Hz to at least 2 MHz. Deflection Factor: 50 mV/div within 5%. X and Y Amplifier Phase Difference: <3° at 50 kHz or less. Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

### TRIGGER

**Trigger Modes** — Auto (enhanced), Normal (auto button out), Single Sweep.

**Enhanced Automatic Triggering** — In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, Line Ext.

**Trigger Coupling** — Dc, ac, ac LF Rej.

**Trigger Sensitivity**[*1]

| Source | dc to 5 MHz | 5 MHz to 15 MHz |
|---|---|---|
| CH 1, CH 2 | 0.4 div | 1.0 div |
| External | 60 mV | 150 mV |

*[1] *Minimum p-p signal required.*

With ac coupling requirements increase below ≈50 Hz. Ac LF Rej coupling requirements increase below ≈5 kHz.

**Triggering Level Range** — Internal: At least ±8 division. External: At least ±1.2 V.

**External Triggering Input** — Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

**Auto Mode** — Sweep free-runs in the absence of a triggering signal. Trigger Level range is reduced to approximately the p-p range of the triggering signal.

**Single Sweep** — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. Auto push button must be in the Out position for operation and for setting triggering controls.

**Trigger Holdoff** — At least 20 to 1 range. The Variable control is internally selectable between the Variable Sweep or Variable Holdoff functions.

### CRT

**Phosphor** — GH (P31) is standard.

**Deflection** — Electrostatic.

**Acceleration Potential** — ≈12 kV.

**Graticule** — Scale, 8 x 10 division with 0.25 in/div internal graticule lines.

## ORDERING INFORMATION

**SC 502** 15 MHz Oscilloscope **$2,795**

**Includes:** Instruction manual (070-1878-01).

**RECOMMENDED PROBES**

P6101A 1X, P6102A 10X, P6062B 1X/10X. See pages 430 and 432.

Compatible accessories begin on page 403.



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## PRODUCT SUMMARY

The CG 5001 is the computerized solution to large-scale scope calibration needs. The CG 5001 can be used as part of a computer-based system to calibrate and verify all major oscilloscope parameters, and is specifically designed for use where many oscilloscopes are maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

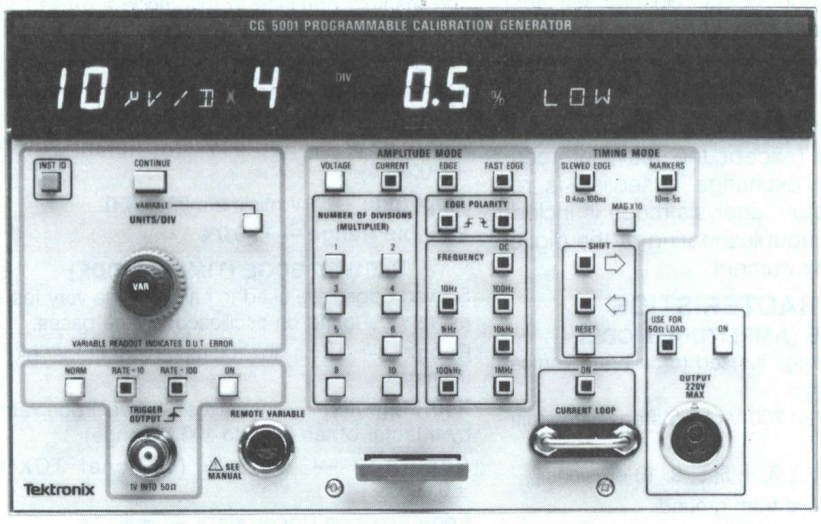
In addition to the CG 5001, TM 500 offers a complete set of calibration instruments that can be configured into a portable test set for in-field oscilloscope service and calibration. These TM 500 oscilloscope calibration instruments offer the widest range of standard amplitude squarewaves, fastest risetimes, lowest aberrations, fastest time marks and widest frequency range of leveled sinewaves available today.

The TG 501 Time Mark Generator provides crystal-controlled time marks from 5 s to 1 ns, plus a variable mode of operation which allows you to read the oscilloscope's timing error directly in percent from the digital display.

The PG 506 Calibration Generator provides clean, fast-rise squarewaves for checking oscilloscope transient response and calibrated-amplitude squarewaves for checking and setting the vertical amplifier gain of the oscilloscope. Like the TG 501, the PG 506 has a variable mode of operation which allows you to read the oscilloscope's calibration error directly in percent from its digital display.

The SG 503 and SG 504 generators provide leveled sinewaves for bandwidth checks (−3 dB points) and triggering performance checks. The SG 503 is a general-purpose leveled sinewave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled sinewave output that is variable from 245 MHz to 1050 MHz in two bands. The SG 502 Oscillator benefits calibration applications where verification of low frequency rolloff in ac modes and performance measurement of low-frequency-reject triggering modes is required.

**CG 5001**




**Programmable Oscilloscope Calibration Generator**

## OSCILLOSCOPE CALIBRATION SELECTION GUIDE

| | Primary Functions | Secondary Functions |
|---|---|---|
| CG 5001 Programmable Calibration Generator | Amplitude Calibration 40 μV to 200 V Time Base Calibration 0.4 ns to 5 s | Testing risetime and transient response, attenuator compensation, oscilloscope nonlinearity |
| PG 506 Calibration Generator | Amplitude Calibration 200 μV to 100 V | Testing risetime and transient response, attenuator compensation |
| TG 501 Time Mark Generator | Time Base Calibration 1 ns to 5 s | Testing oscilloscope nonlinearity |
| SG 503 Signal Generator | Bandwidth Calibration 250 kHz to 250 MHz | General leveled RF signal source |
| SG 504 Signal Generator | Bandwidth Calibration 245 MHz to 1050 MHz | General leveled RF signal source with frequency modulation capability |

# CG 5001

GPIB IEEE-488 The CG 5001 is designed to support other products which comply with IEEE Standard 488-1978.

The Tektronix CG 5001 Programmable Oscilloscope Calibration Generator is a microprocessor-based generator that can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

- **Vertical Gain**
- **Horizontal Timing and Gain**
- **Vertical Bandwidth/Pulse Characteristics**
- **Probe Accuracy and Compensation**
- **Current Probe Accuracy**
- **Calibrator Output Accuracy**

The CG 5001's front panel features a wide range of functions, many of which represent a new state-of-the-art in calibration performance. All these functions are programmable by a controller via the GPIB (General Purpose Interface Bus). A "Learn" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system can provide step-by-step instructions to the operator, thus significantly reducing the skill level required.

Many of the calibration and test steps previously performed by the operator can now be transferred to a computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program can send control-setting information to the CG 5001, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions can be placed on a terminal to automatically coordinate the operator with the calibration signals being sent from the CG 5001. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 5001 returns error or deviation information to the controller, where it can be compared with preprogrammed reference values for the oscilloscope. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as a hard copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

The CG 5001 is designed to greatly reduce your maintenance costs. Built-in self test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

## CHARACTERISTICS

### VOLTAGE (AMPLITUDE MODE)

The standard voltage is used to calibrate vertical display accuracy.

**Range** — 40 μV to 200 V (1-2-5 steps with multiplier).

**Multipliers** — 1, 2, 3, 4, 5, 6, 8, 10 divisions.

**Polarity** — Positive from ground.

**Accuracy** — +0.25% ±1 μV.

**Frequency** — 40 mV to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: dc or 10 Hz to 100 kHz. 12 V to 200 V: dc or 10 Hz to 10 kHz.

**Variable Range** — ±9.9%.

### CURRENT (AMPLITUDE MODE)

The standard current is used to calibrate current probes.

**Range** — 1 mA to 100 mA (1-2-5 sequence).

**Multipliers** — 1, 2, 3, 4, 5, 6, 8, 10.

**Accuracy** — ±0.25% ±2 μA.

**Frequency** — Dc or 10 Hz to 1 MHz (decade steps).

**Droop** — ≤1%.

**Variable Range** — ±9.9%.

### LOW EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

**Range** — 20 mV to 1 V p-p (50 Ω load only) (1-2-5 steps with multipliers).

**Multipliers** — 1, 2, 3, 4, 5, 6, 8, 10.

**Polarity** — Positive or negative transitions to ground.

**Risetime (Falltime)** — ≤1.3 ns.

**Abberrations** — ±2%.

**Long Term Flatness** — ±0.5% after first 10 ns.

**Frequency** — 10 Hz to 1 MHz (decade steps).

**Variable Amplitude Range** — > ±9.9% from nominal.

### HIGH EDGE (AMPLITUDE MODE)

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

**Range** — 1.2 V to 100 V ≥1 MΩ load (1-2-5 steps with multipliers).

**Polarity** — Positive transition only (negative voltage to ground).

**Risetime** — <100 ns.

**Aberrations** — ±2% of squarewave amplitude.

**Long Term Flatness** — ±0.5% after first 500 ns.

**Frequency** — 10 Hz to 100 kHz (decade steps).

**Variable Amplitude Range** — > ±9.9% from nominal.

### MARKERS (TIMING MODE)

The markers obtained in this mode are used to calibrate oscilloscope time bases.

**Range** — 10 ns to 5 s (1-2-5 steps).

**X10 Magnifier** — Increase marker rate by a factor of ten (0.1 μs to 5 s range).

**Accuracy** — ±0.01% (optional TCXO ±0.0003%).

**Amplitude** — 1 V minimum into 50 Ω.

**Variable Range** — ±9.9%.

### SLEWED EDGE (TIMING MODE)

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.

**Range** — 0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).

**X10 Magnifier** — Increases Slewed Edge rate by a factor of ten (5 ns to 100 ns range).

**Accuracy** — ±0.01% (Optional TCXO ±0.0003%).

**Edge Position Uncertainty** — ±40 ps.

**Amplitude** — >1 V into 50 Ω.

**Variable Range** — ±9.9%.

### TRIGGER OUTPUT

The oscilloscope under test is normally triggered externally from this source.

**Output Amplitude** — 1 V minimum into 50 Ω.

**Trigger Rate (Marker Mode)** — Normal: Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers. Divided by 10: Reduces normal trigger rate by a factor of ten. Divided by 100: Reduces normal trigger rate by a factor of one hundred.

**Slewed Edge Mode** — One trigger per slewed edge.

**All Other Modes** — Normal: Slaved to output frequency. Divided by 10: One-tenth output frequency. Divided by 100: One-hundredth output frequency.

### TIMING REFERENCE OUTPUT

### EXTERNAL TIMING REFERENCE

**Input Frequency** — Any integral multiple of 1 MHz up to 5 MHz.

**Required Accuracy** — ±0.001%.

**Input Amplitude** — 1 V to 10 V RMS.

**Input Resistance** — 10 kΩ (nominal).

### ENVIRONMENTAL

Meets or exceeds MIL-T-28800B, Class 5 requirements.

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: Displacement (p-p), 0.015 inch. Vibration Frequency: 10 Hz to 55 Hz. Total time: 75 minutes.

**Relative Humidity** — 90% to 95% at +50°C for 5 days.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration, three shocks in each direction along three major axes; total shocks, 18.

**Bench Handling** — Operating: 45° 4 inches or point of balance, whichever occurs first.

### PHYSICAL CHARACTERISTICS*1

| Dimensions | mm | in |
|---|---|---|
| Width | 203 | 8.0 |
| Height | 124 | 4.9 |
| Depth | 305 | 12.0 |
| **Weights** | **kg** | **lb** |
| Standard | 3.9 | 8.5 |
| Option 01 | 4.0 | 8.7 |

*1 *Maximum Overall Dimensions (triple compartment plug-in).*

### PULSE HEAD (STANDARD ACCESSORY) FAST EDGE (AMPLITUDE MODE)

The Pulse Head is used to generate fast rise, low distortion pulses for testing higher bandwidth vertical amplifiers.

**Polarity** — Positive or negative transitions from ground.

**Risetime** — ≤200 ps.

**Aberrations** — ±3% of pulse amplitude; not to exceed 4% p-p for adjacent peaks.

**Frequency** — 100 Hz to 100 kHz (decade steps).

**Amplitude** — 1.1 V peak ±5% into 50 Ω.

**Variable Range** — ±10%.

## ORDERING INFORMATION

**CG 5001** Programmable Calibration Generator **$14,995**

**Includes:** Output cable assembly (012-0884-00); pulse head (015-0311-01); instrument interface guide (070-4616-00); program CAL GEN (070-4768-00); instruction manual (070-4767-00).

**CG 551AP** Programmable Calibration Generator **$14,995**

### OPTIONS

**Option 01** — Adds High Accuracy Time Base (TCXO) CG 5001/CG 551AP. **+$650**

**Option 02** — Deletes Pulse Head CG 5001/CG 551AP. **−$1,100**

**Utility Software**
For TM 5000/4041. Order 062-6958-01 **$150**

See page 297 for description and ordering information.

### CONVERSION KIT

**CG 551AP** — Field Modification Kit to convert to CG 5001. Order 040-1041-02 **$140**

### MAINFRAMES

CG 5001 requires either a TM 5003 or TM 5006. The CG 551AP is a TM 500 version of the CG 5001 and requires a TM 506 Mod JB, TM 515 Mod UB or RTM 506 Mod JB. The CG 5001 is not compatible with TM 500 power module mainframes.

## OPTIONAL ACCESSORIES

**Comparator Head** — Used to calibrate built-in oscilloscope calibrators against the signals available from the CG 5001. Both the oscilloscope calibrator and CG 5001 standard amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 5001 signals are then varied to obtain congruent displays. Errors are then displayed on the CG 5001 readout.
Order 015-0310-01 **$500**

**Remote Variable** — Permits remote operation of the following front panel controls: Units/Div, Variable-Fixed Button, Continue Pushbutton and the VAR. Order 015-0309-01 **$375**

**Pulse Head** — (When purchased separately.)
Order 015-0311-01 **$1,400**

**Rigid Circuit Board Extender** —
Order 067-0975-00 **$100**

**Flexible Circuit Board Extender** —
Order 067-0974-00 **$115**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

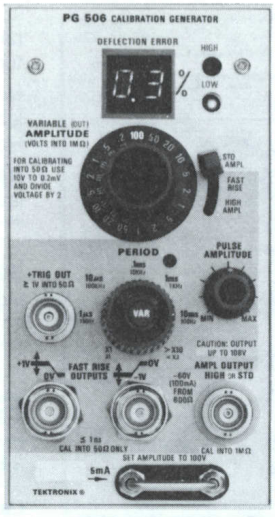
# PG 506

**Three Squarewave Output Modes**

**10 Hz to 1 MHz**

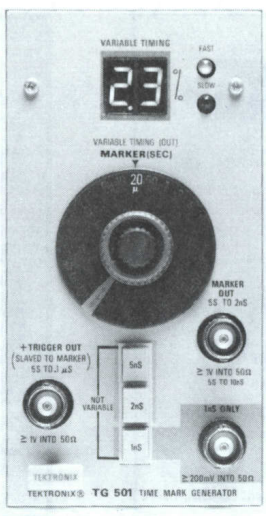
**Direct Readout of Oscilloscope Deflection Error**

PG 506




Calibration Generator

TG 501




Time Mark Generator

The PG 506 Calibration Generator provides three modes of squarewave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. Simultaneous plus and minus low-level, fast-rise (1.0 ns) squarewaves or high amplitude (60 V), extremely clean squarewaves are available at frequencies from 10 Hz through 1 MHz for checking oscilloscope transient response. A 5 mA calibration current loop is useful for current probe calibration. A 1 kHz squarewave can be generated in the amplitude calibration mode. Its amplitude may be varied around the calibrated level until the squarewave aligns with the oscilloscope vertical graticule divisions. Scope deflection error then can be read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

## CHARACTERISTICS

### AMPLITUDE CALIBRATOR MODE

**Period** — Fixed at ≈1 ms or dc.

**Amplitude** — From 200 μV p-p to 100 V p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 100 μV p-p to 5 V p-p into 50 Ω.

**Error Readout** — Range: ±7.5%. Resolution: 0.1%.

### PULSE MODES

**Period** — 1 μs to 10 ms (within 5%) in decade steps with the variable control in Cal position. Variable extends period to at least 100 ms.

**Symmetry** — ≈50% duty cycle.

### HIGH AMPLITUDE OUTPUT

**Risetime** — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

**Amplitude Range** — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

**Leading Edge Aberrations** — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

**Polarity** — Positive going from a negative potential to ground.

**Output Resistance Source** — 600 Ω within 5%.

### FAST-RISE OUTPUTS

**Risetime (Terminated Into 50 Ω)** — <1.0 ns.

**Amplitude Range (Terminated Into 50 Ω)** — 100 mV or less to at least 1.0 V.

**Leading Edge Aberrations** — Within 2% or 10 mV p-p, whichever is greater, during first 10 ns.

**Flatness** — Within 0.5% after first 10 ns.

**Polarity** — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

**Output Resistance Source** — 50 Ω within 3% at + and − output connectors.

**Trigger Output (Terminated into 50 Ω)** — Positive-going signal of at least 1 V.

## ORDERING INFORMATION

**PG 506** Calibration Generator **$2,995**

**Includes:** Instruction manual (070-3383-00).

### Tunnel Diode Pulser

The Tunnel Diode Pulser provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. It can be driven by the PG 506 at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 Ω, while risetime is ≤125 ps; aberrations are <1% in a 1 GHz system.

## ORDERING INFORMATION

**Tunnel Diode Pulser** Order 067-0681-01 **$185**

### Precision Voltage Divider

Designed for use with the PG 506 in the Standard Amplitude mode, this 0.4 divider allows your oscilloscope to display a constant four divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display five divisions of amplitude.

## CHARACTERISTICS

**Input Z** — 50 Ω with output load ≥100 kΩ.

**Maximum Input** — ≤5 V RMS.

**Output** — 0.4 x PG 506 amplitude.

**Voltage Accuracy** — ±0.4%.

## ORDERING INFORMATION

**Precision Voltage Divider**
Order 015-0265-00 **$140**

Compatible accessories begin on page 448.

# TG 501

**Marker Outputs, 1 ns to 5 s**

**Direct Readout of Oscilloscope Timing Error**

**External Trigger Output**

The TG 501 Time Mark Generator provides marker outputs from one nanosecond to five seconds. A unique feature on the TG 501 is a variable timing output with a front-panel two-digit LED display. The display indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

## CHARACTERISTICS

**Markers** — 1 ns through 5 s in a 1-2-5 sequence.

**Marker Amplitude** — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

**Trigger Output Signal** — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

| Internal Time Base | Standard | Option 01 |
|---|---|---|
| Crystal Frequency | 1 MHz | 5 MHz |
| Stability (0°C to 50°C) after ½ hour | within 1 part in $10^5$ | within 5 parts in $10^7$ |
| Long-Term Drift | 1 part or less in $10^5$ per month | 1 part or less in $10^7$ per month |
| Setability | adjustable to within 1 part in $10^7$ | adjustable to within 5 parts in $10^9$ |

**External Reference Input** — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

**Timing Error Readout Range** — To ±7.5%.

**Timing Error Measurement Accuracy** — Device under test error is indicated to within one least significant digit (to within one displayed count).

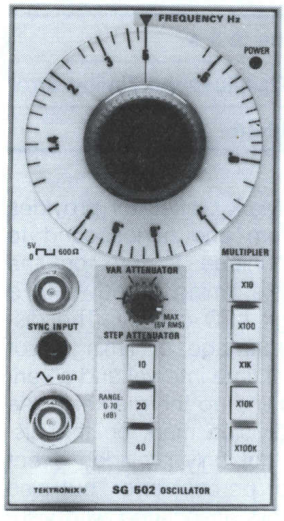
## ORDERING INFORMATION

**TG 501** Time Mark Generator **$2,495**

**Includes:** Instruction manual (070-1576-02).

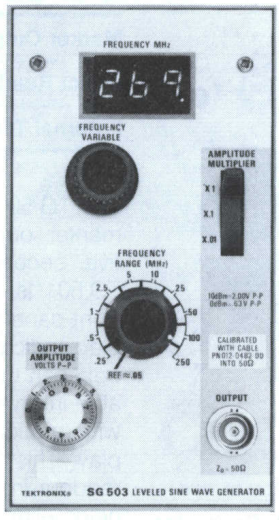
**Option 01** — 5 MHz Time Base. **+$325**

**SG 502**



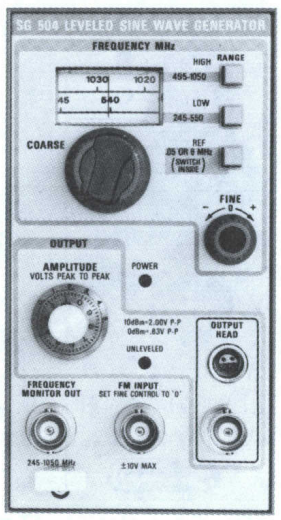

Oscillator

**SG 503**




Signal Generator

**SG 504**




Signal Generator

# SG 502

**5 Hz to 500 kHz Sinewaves and Squarewaves**

**Low Distortion Sinewave**

**5 V RMS Open Circuit—600 Ω Source**

**0 dB to 40 dB Output Variable Plus 0 dB to 70 dB in 10 dB Steps**

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes. Other SG 502 features include 70 dB amplitude control plus a simultaneous fixed amplitude squarewave.

## CHARACTERISTICS

### SINEWAVE

**Frequency Range** — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

**Amplitude Response (1 kHz Reference)** — Flatness is 0.3 dB over entire range.

**Attenuation** — Selectable from 0 dB to 70 dB in 10 dB, 20 dB, and 40 dB steps with push buttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to −40 dB.

**Harmonic Distortion** — <0.035% (−70 dB) from 20 Hz to 50 kHz. <0.15% from 50 kHz to 500 kHz ($R_L$ ⩾600 Ω).

**Maximum Output Voltage** — 5 V RMS open circuit; 2.5 V RMS into 600 Ω.

**Output Impedance** — 600 Ω, grounded.

### SQUAREWAVE

**Frequency Range and Accuracy** — Same as sinewave. The squarewave switches on the 0° phase of sine out.

**Risetime and Falltime** — 50 ns or less.

**Amplitude** — +5 V, fixed, open circuit.

**Output Impedance** — 600 Ω, grounded.

### SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

**Input Impedance** — 10 kΩ.

## ORDERING INFORMATION

**SG 502** Oscillator **$995**

**Includes:** Instruction manual (070-1430-01).

# SG 503

**250 kHz to 250 MHz**

**Leveled, Variable Output**

**Digital Readout of Frequency**

The SG 503 Signal Generator provides a leveled output that is variable in frequency from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage is variable from 5 mV to 5.5 V peak-to-peak into 50 ohms.

## CHARACTERISTICS

**Frequency Range** — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

**Frequency Accuracy** — Within ±0.7 of one count of the least significant digit of indicated frequency.

**Amplitude Range** — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

**Amplitude Accuracy (50 kHz Reference)** — Within 3% of indicated amplitude on (X1) range, 4% on (X.1) range, and 5% on (X.01) range.

**Flatness (P-P)** — From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X.1 and X.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

**Harmonic Content** — Second Harmonic: At least 35 dB down. Third Harmonic and All Higher Harmonics: At least 40 dB down.

**Rear Card Edge Connection** — Address the leveling circuit.

## ORDERING INFORMATION

**SG 503** Signal Generator **$2,400**

**Includes:** Three foot precision 50 Ω cable (012-0482-00); instruction manual (070-1622-01).

# SG 504

**245 MHz to 1050 MHz**

**Leveled, Variable Output**

**Frequency Modulation Capability**

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V p-p into 50 Ω.

## CHARACTERISTICS

**Frequency Range** — Low Band: 245 MHz to 550 MHz. High Band: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

**Frequency Accuracy** — ±2% of dial indication.

**Amplitude Range** — 0.5 V to at least 4.0 V p-p.

**Amplitude Accuracy (At Reference)** — Within 3% of indicated amplitude.

**Flatness** — ±4% of amplitude at reference frequency.

**Harmonic Content** — Second Harmonic: At least 25 dB down. Third Harmonic and All Higher Harmonic: At least 40 dB down.

**FM Input** — Frequency Range: Dc to 100 kHz. Deviation Sensitivity: ±9 V produces from ±0.05% to ±0.5% deviation of carrier, depending on output frequency.

**Frequency Monitor Output** — ⩾0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

**Rear Card Edge Connections** — Address FM input, frequency monitor output, and amplitude control.

## ORDERING INFORMATION

**SG 504** Signal Generator (Includes Leveling Head) **$3,995**

**Includes:** Instruction manual (070-1632-01).

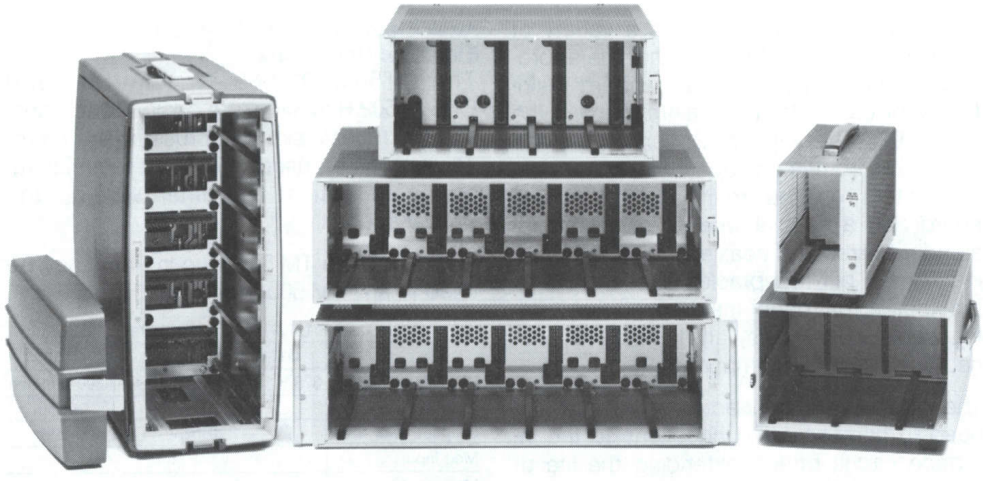
**Replacement Leveling Head**
Order 015-0282-00 **$450**

**Tektronix offers service training classes on the TM 500 Calibration Systems Package. For further training information, contact your local Sales/Service Office or request a copy of the Customer Service Training Catalog on the return card in the back of this catalog.**

Compatible accessories begin on page 448.



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99



*Shown above are the TM 515, TM 504, TM 506, RTM 506, TM 501 and TM 503 mainframes.*

The TM 500 mainframes and plug-ins allow the multifunctionality of a package of instruments. Hundreds of instrumentation packages for specific tasks can be configured.

The TM 500 plug-ins operate in any of six mainframes. One single-width plug-in instrument is accommodated by the TM 501. Up to six instruments can be accommodated in the TM 506 bench-top mainframe and the RTM 506 rackmount mainframe. Three and four-wide mainframes are also available and the five-wide Traveler Mainframe provides for applications that require portability.

### Benchtop

Four benchtop mainframes are available. The TM 501 is the most compact. The TM 503 accommodates three single-wide plug-ins. The TM 504 and TM 506 each include a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. The TM 506 incorporates a quiet fan for optimum cooling. All benchtop models have feet, tilt-bails, handles, front-panel power switches and operate from 110 V ac to 220 V ac.

### Portability

All benchtop models have carry handles, sturdy cordwrap rear feet plus optional protective front covers to further enhance portable applications. The TM 515 Traveler Mainframe, designed for superior, multi-instrument portability, is a handsome piece of luggage with molded feet on the bottom and a comfortable, luggage-type handle. It is extremely moisture and dust resistant and designed to withstand the rigors of transport in car trunks and pickup trucks. The rear cover pops off to access the power cord, power switch and allow airflow for the built-in fan.

### Rackmount

The RTM 506 rackmount mainframe is electrically identical to the TM 506. It features a slide assembly and handles, plus a higher-power fan to accommodate the higher ambient temperatures often found in enclosed racks and consoles. It is also possible to convert two TM 503's into a rackmount assembly with a kit. This kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications, but lacks the fan and the high-power compartments. Other kits are available to rackmount a single TM 503 or a TM 503 with a monitor.

### Rear Interface Capability

Most TM 500 plug-in modules contain a duplication of the front-panel input and output connections in the back. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. These signals are available at the rear edge-card connector of each plug-in. Any module can be internally connected through the mainframe and also externally interfaced out the back panel.

The TM 515 traveler mainframe is available with the Option 05 interface which includes everything in the Option 02 except the rear panel multi-pin connector, the mating cable connector, and the BNC connector.

### Economy

Reduced cabling costs made possible by the rear-interface capability, and the reduced space requirements for a measurement system all contribute to unprecedented economy for test and measurement requirements.

## CHARACTERISTICS

### ENVIRONMENTAL

**Temperature Range —** Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude Range —** Operating: Sea level to 4600 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

### POWER REQUIREMENTS

All of the mainframes have manually selectable taps on the power transformer which permit operation on 100 V, 110 V, 120 V, 200 V, 220 V, or 240 V ±10%.

**Power Line Frequency Range —** TM 501/TM 503: 48 Hz to 440 Hz. TM 504/TM 506/RTM 506/TM 515: 48 Hz to 66 Hz. TM 515 (Purchased with Option 06): Extends upper power line frequency range to 440 Hz.

**Maximum Power Consumption —** See table

## ORDERING INFORMATION

| | |
|---|---|
| **TM 501** Power Module Mainframe<br>**Includes:** Instruction manual (070-1304-01). | **$425** |
| **Option 02** — Rear Interface. | **+$60** |
| **TM 503** Power Module Mainframe<br>**Includes:** Instruction manual (070-1305-01). | **$390** |
| **Option 02** — Rear Interface. | **+$90** |
| **TM 504** Power Module Mainframe<br>**Includes:** Instruction manual (070-1716-02). | **$480** |
| **Option 02** — Rear Interface. | **+$120** |
| **TM 506** Power Module Mainframe<br>**Includes:** Instruction manual (070-1786-02). | **$660** |
| **Option 02** — Rear Interface. | **+$180** |
| **RTM 506** Rackmount Power Module Mainframe<br>**Includes:** Instruction manual (070-1786-02). | **$725** |
| **Option 02** — Rear Interface. | **+$190** |
| **TM 515** Power Module Mainframe<br>**Includes:** Instruction manual (070-2020-02). | **$690** |
| **Option 05** — Rear Interface. | **+$90** |
| **Option 06** — 48 Hz to 440 Hz Fan. | **+$170** |

### OPTIONAL ACCESSORIES

**Rear Interface Data Book —**
Order 070-2088-04 **$12.00**

## Mainframes Dimensions and Weights (Without Plug-Ins)

| | TM 501 | | TM 503 | | TM 504 | | TM 506 | | RTM 506 | | TM 515 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** | **mm** | **in** |
| Width | 99 | 3.9 | 221 | 8.7 | 305 | 12.0 | 442 | 17.4 | 483 | 19.0 | 381 | 15.0 |
| Height | 152 | 6.0 | 152 | 6.0 | 152 | 6.0 | 152 | 6.0 | 133 | 5.3 | 173 | 6.8 |
| Depth | 389 | 15.3 | 432 | 17.0 | 508 | 20.0 | 508 | 20.0 | 480 | 18.9 | 508 | 20.0 |
| **Weight ≈** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Net | 2.4 | 5.4 | 4.3 | 9.5 | 8.4 | 18.5 | 13.2 | 29.0 | 14.4 | 32.0 | 10.2 | 22.5 |
| Shipping | 5.9 | 13.0 | 7.7 | 17.0 | 11.8 | 26.0 | 18.6 | 41.0 | 21.0 | 46.0 | 13.6 | 30.0 |
| Max Power Consumption*[1] | 85 VA | | 250 VA | | 460 VA | | 670 VA | | 670 VA | | 500 VA | |

*[1] *Actual power consumption depends on plug-in selection and operating modes.*

**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

### MAINFRAME RACKMOUNT-TO-CABINET AND CABINET-TO-RACKMOUNT CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit —** Equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is used. Order 040-0617-02 **$240**

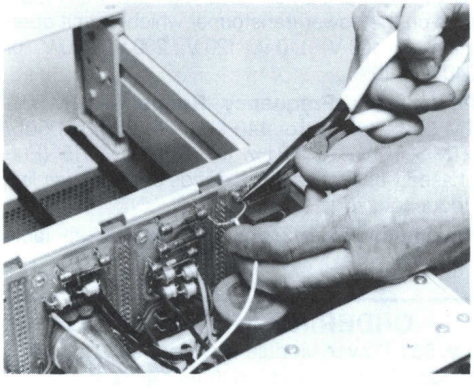
**Cabinet-to-Rackmount Conversion Kit —** Equipped with slide-out assembly, required to rackmount two TM 503's side-by-side in a standard rack width. Order 040-0616-02 **$160**

**Rackmount-to-Cabinet Conversion Kit —** Equipped to convert a rackmount TM 503 to a cabinet style. Order 040-0618-01 **$85**

**Cabinet-to Rackmount Conversion Kit —** Equipped with slide-out assembly, required to convert a TM 506 (cabinet style) to an RTM 506. Order 040-0761-04 **$190**

**Rackmount-to-Cabinet Coversion Kit —** Equipped to convert an RTM 506 to cabinet style TM 506. Order 040-0762-00. **$105**

### Mainframe Rear Interface



TM 5000/TM 500 mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage set-ups without any need to move test leads. Any module can be internally connected through the mainframe and can also be externally interfaced out the back panel.

TM 5000/TM 500 plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines which are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

The TM 515 mainframe is available with an Option 05 interface that includes everything in the Option 02 except for the rear panel male connector, mating cable connector and the BNC connectors.

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 5000/TM 500 mainframe except the TM 501. The kit includes fourteen square pins, and three coaxial cables, all with female pin receptacles. Installation instructions also included. For "do-it-yourself" modification kit:

### ORDERING INFORMATION

**Mainframe Rear Interface**
Order 040-0846-01 **$55**

### *NEW* Electrical/Optical Optical/Electrical Converters

The OT501/502/503 Transmitters and OR501/502 Receivers are designed to transmit and receive signals across fiber. The receivers can be used to convert most instruments to optical instruments (e.g., the optical scope).

Designed as a TM 500 plug-in, they may be used in any TM 500 mainframe.

**OT501/502/503 Transmitters**

| | OT501 | OT502 | OT503 |
|---|---|---|---|
| Wavelength | 825 ±15 nm | 850 ±10 nm | 1300 ±25 nm |
| FWHM* | <2 nm | | <4 nm |
| Output Power, Dc | +3 dBm | | 0 dBm |
| Mod Input | 50 Ω | | |
| Mod Input Level Max w/100% Mod | +20 dBm<br><0 dBm | | |
| Mod Freq Response | .03 to 1700 MHz | | .03 to 1500 MHz |
| Mod Flatness | ±1 dB (.05 to 1000 MHz) | | |
| | ±2 dB (.03 to 1700 MHz) | | ±5 dB (.03 to 1500 MHz) |

**OR501/502 Receivers**

| | OR501 | OR502 |
|---|---|---|
| Wavelength | 700 to 1500 nm | |
| Photo Element | Ge-APD | |
| Max Linear Input | −20 dBm | +10 dBm |
| Frequency Response | .03 to 1500 MHz ±2 dB<br>.05 to 1000 MHz ±1 dB | |
| Noise Floor | ⩽−110 dBm/Hz | |
| Output 50 Ω | −15 dBm typical for −20 dBm optical input | −12 dBm typical −20 dBm optical input |
| Optical Attenuator | N/A<br>N/A | 2.5 dB/step (Nom)<br>37.5 dB (Max) |

** Full wave half maximum.*

### ORDERING INFORMATION

**OT501** — 825 nm E/O Converter. **$5,900**
**OT502** — 850 nm E/O Converter. **$5,900**
**OT503** — 1300 nm E/O Converter. **$9,500**
**OR501** — O/E Converter. **$4,300**
**OR502** — O/E Converter. **$6,500**

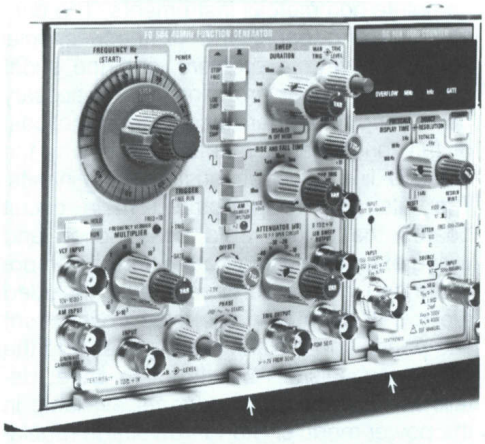
**OPTIONS**

**Option 20** — AT&T Biconic Connector. **NC**
**Option 21** — Diamond 3.5 Connector. **NC**
**Option 22** — FC Connector. **NC**
**Option 23** — SMA Connector. **NC**



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

### Mainframe Retainer Bar



The mainframe retainer bar modification kit comes complete with the retainer bar, all necessary parts and instructions.

You may modify the TM 504 or RTM 506/TM 506 mainframe; each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit. Then, the retainer bar can be simply added or removed with four screws accessible from the bottom of the mainframe.

#### ORDERING INFORMATION

**TM 504** Mainframe Retainer Bar Kit. Order 020-0548-00 **$45**

**TM 506/RTM 506** Mainframe Retainer Bar Kit. Order 020-0549-00 **$50**

### Protective Front Cover

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 mainframes. The cover adds 45 mm (1.75 in) to the length of the TM 503, TM 504, and TM 506 mainframes, and clears the longest knob projections on any of the instruments.

#### ORDERING INFORMATION

**TM 503** Front Panel Cover. Order 200-1566-00 **$18**

**TM 504** Front Panel Cover. Order 200-1727-00 **$17**

**TM 506** Front Panel Cover. Order 200-1728-00 **$20**

### Accessory Pouch

While the TM 501, TM 503, TM 504, and TM 506 TM 5003/TM 5006 mainframes were designed primarily for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 5000/TM 500 mainframe or Tektronix Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions ≈9¼ in long x 5¾ in wide x 2 in high.

#### ORDERING INFORMATION

**Accessory Pouch.** Order 016-0351-00 **$25**

### 1105 Battery Power Supply

TM 500 instruments in their mainframes may be operated with the 1105 Battery Power Supply when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full mainframe in a typical situation.

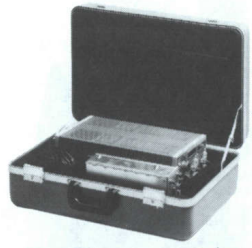
| | |
|---|---|
| TM 501 | 5.0 hours |
| TM 503 | 1.6 hours |
| TM 504 | 1.3 hours |
| TM 506 | 0.9 hours |
| TM 515 | 1 hour |

#### ORDERING INFORMATION

**1105** Battery Pack **$1,650**

**Option 01** — 230 V Operation **NC**

### TM 500 Carrying Case



These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½ inches long by 8½ inches thick by 15 3½ inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200 Series miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert that will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 610 mm long x 216 mm thick x 445 mm high, (24 in long by 8.5 in thick by 17.5 in high) and weighs ≈14 pounds empty.

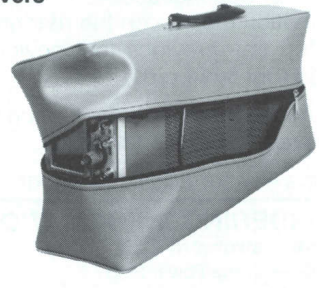
#### ORDERING INFORMATION

**TM 503 Carrying Case.** Order 016-0565-00 **$395**

**TM 504 Carrying Case.** Order 016-0608-00 **$425**

**TM 515 Carrying Case.** Order 016-0643-00 **$450**

### Rain Covers



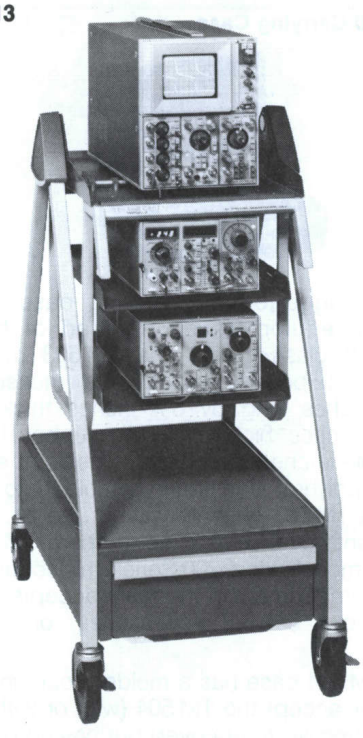
These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 instrumentation packages and include adequate space for protective front covers, as well. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

#### ORDERING INFORMATION

**TM 504** Rain Cover. Order 016-0621-00 **$45**

**TM 503** Rain Cover. Order 016-0620-00 **$35**

**K213**



*K213 shown with 436-0132-01 optional shelf.*

This Lab Cart is especially designed for a rollabout configuration combining TM 5000/TM 500 Instrumentation with the Tektronix oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray accepts all TM 5000/TM 500 Series mainframes which accept up to four plug-in modules, or any Tektronix 7000 Series, 5000 Series, or portable oscilloscope. The K213 comes standard with one lower shelf. Additional shelves are available as optional accessories. The power distribution module on the rear underside of the top tray provides four power outlets and a 15 foot line cord.

International modification (Option 01) deletes power distribution module.

See page 424 for additional information.

## ORDERING INFORMATION

**K213 Lab Instrument Cart** — **$595**

**Option 05** — Delete Power Strip — **NC**

**Additional Lower Shelf** — Order 436-0132-01 — **$50**

**Safety Belt** to secure oscilloscopes or TM 5000/TM 500 to top tray or lower shelves (not needed for 5000 Series or 7000 Series on top tray). Order 346-0136-01 — **$26**

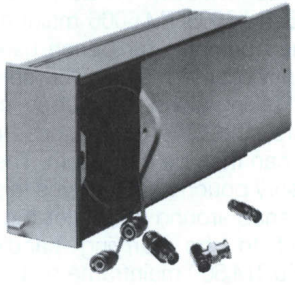
### TM 5000/TM 500 Blank Plug-in Panel

When operating TM 5000/TM 500 instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

## ORDERING INFORMATION

**Blank Plug-in Panel**
Order 016-0195-03 — **$25**

### Plug-in Storage Compartment

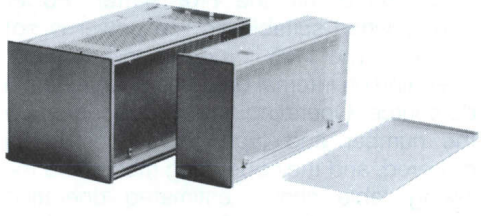


An electronic engineer or technician away from their bench seldom has enough storage space for probes, cables, "tees", accessories, and small tools. The plug-in storage compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 mainframes and 5000 Series oscilloscope mainframes; inside dimensions 250 mm L x 51 mm W x 106 mm H, (9⅞ in L x 2 in W x 4¼ in H).

## ORDERING INFORMATION

**Plug-in Storage Compartment**
Order 016-0362-01 — **$125**

### TM 500 Custom Plug-in Kits



**Single and Double Compartment Sizes**
A complete test and measurement set-up for many typical jobs requires at least one nonstandard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceeds the cost of the functional elements. This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards that allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator ICs can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 instrumentation.

**Single Compartment with Power Supply**
A blank plug-in kit complete with power supply parts and circuit board layout is now available. A single-wide compartment, this plug-in kit saves set up and build time as the power supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

(1) A ground-referenced positive supply, capable of +7 V to +20 V at up to 400 mA. (Adjustment is centered at 15 V; change of resistor values required for total 7 V to 20 V range).

(2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.

(3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 construction notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits and Thermal True RMS Converter:

## ORDERING INFORMATION

**Custom Plug-in Kit** — Single Compartment with Power Supply.
Order 040-0803-02 — **$115**

**Custom Plug-in Kit** — Single Compartment. Order 040-0652-05 — **$95**

**Custom Plug-in Kit** — Double Compartment. Order 040-0754-07 — **$125**

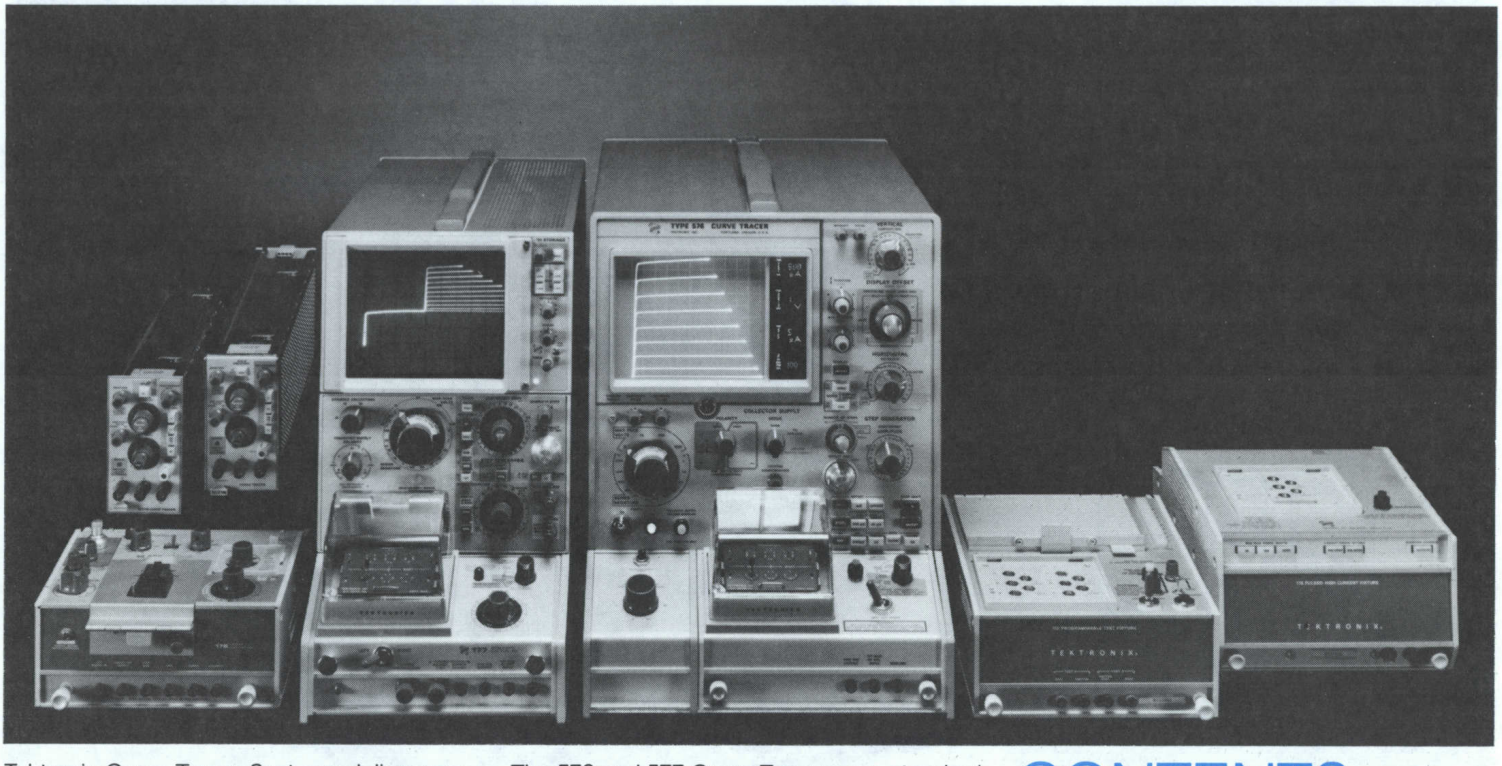
**Custom Plug-in Kit** — Single Compartment Without ECB.
Order 040-0821-03 — **$60**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

# CURVE TRACERS



Tektronix Curve Tracer Systems deliver comprehensive information for accurate design, analysis, and evaluation for a multitude of semiconductor devices and integrated circuits. These dynamic parametric testers quickly measure and display the characteristic curves of a wide variety of two and three terminal devices including diodes, transistors, thyristors, and optoisolators, and the full range of linear ICs including operational amplifiers, comparators, differential amplifiers, and voltage regulators.

The 576 and 577 Curve Tracers use standard plug-in test fixtures for a variety of low or high current applications. The 172 Programmable Test Fixture and the 176 Pulsed High-Current Fixture are designed for use in the 576. The 178 Linear IC Test Fixture is designed for use in the 577.

The 5CT1N and 7CT1N plug-in units are designed for use in the 5000 Series and 7000 Series oscilloscopes respectively.

## CONTENTS


**576** Curve Tracer System ..... 394
**172** Programmable Test Fixture ..... 396
**176** Pulsed High-Current Fixture ..... 397
**577/177** Curve Tracer System ..... 398
**178** Linear IC Test Fixture ..... 400
Socket Adaptors ..... 401
**5CT1N & 7CT1N** Curve Tracer Plug-Ins ..... 402


The following Curve Tracer System descriptions will help you choose the system that best meets your requirements. Additional information is available. Contact your local sales engineer or use the reply card in the back of this catalog.

### TEST FIXTURES SELECTION GUIDE

| APPLICATION/FEATURE | 172 | 176 | 177 | 178 | 5CT1N | 7CT1N |
|---|---|---|---|---|---|---|
| Programmable Test Fixture—Up to 11 different tests | ✓ | | | | | |
| Pulsed High Current Fixture—1000 Watt capability | | ✓ | | | | |
| Standard Test Fixture for 577 | | | ✓ | | | |
| Linear IC Test Fixture | | | | ✓ | | |
| Curve Tracer Plug-ins—Test devices up to 0.5 w | | | | | ✓ | ✓ |
| Pulsed collector operation to 200 A Peak | | ✓ | | | | |
| Tests single, dual or quad operational or differential amplifiers, comparators, regulators, etc. | | | | ✓ | | |
| Test Linear IC under low current conditions | | | | ✓ | | |
| Test small signal transistors under pulsed collector breakdown conditions without over dissipation | | ✓ | | | | |
| Mainframe Compatibility: | | | | | | |
| 576 | ✓ | ✓ | | | | |
| 577 | | | ✓ | ✓ | | |
| 5000 Series oscilloscopes | | | | | ✓ | |
| 7000 Series oscilloscopes | | | | | | ✓ |
| Page | 396 | 397 | 398 | 400 | 402 | 402 |
| Prices | $5,225 | $5,760 | $1,390 | $3,475 | $1,050 | $1,740 |

# 576

**Tests Two- and Three-Terminal Discrete Semiconductors**

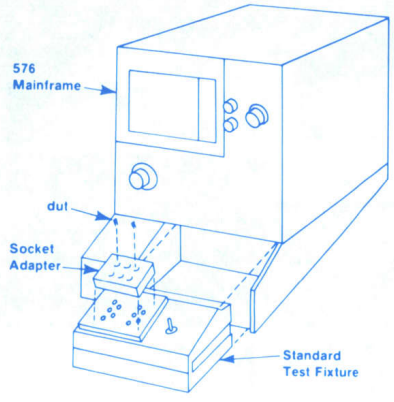
**Power Capability Up to 220 Watts**

**Convenient Scale Factor Readout**

**Other Test Fixtures for Semiautomated Testing and Testing Power Devices to 1000 Watts**

## TYPICAL APPLICATIONS

* **Semiconductor R & D**
* **Production Device Testing**



The Tektronix 576 Curve Tracer System continues to hold the title "standard of the industry". The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (see page 396), and the 176 Pulsed High-Current Fixture (see page 397). The 576 is an excellent general purpose curve tracer system that performs well in applications where high-current testing is required.

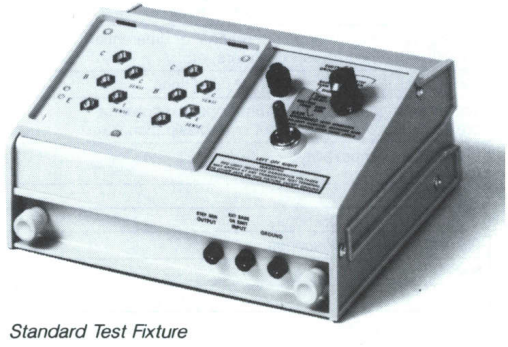
With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the device under test. The step generator can deliver up to two amps in both its current and voltage modes of operation. With the 176 High-Current Fixture, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the Tektronix 577 Curve Tracer System is the display area adjacent to the 576's CRT. These alphanumeric indicators provide readout of vertical and horizontal deflection factors, step amplitude, and Beta/div or $g_m$/div. The Beta or $g_m$ readout saves the operator from the arithmetic usually necessary to arrive at these parameters. These indicators also provide a permanent record of major knob settings in 576 CRT photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer include: adjustable current limiting in the step generator; either 300 $\mu$s or 80 $\mu$s pulse width in pulsed base operation; pushbuttons to check display zero and calibration; and an illuminated graticule.

A safety interlock protects the operator from dangerous voltages. For collector voltages greater than 15 V, a plastic protective safety shield must be in place over the test terminals and its lid closed before collector voltage can be applied.



*Standard Test Fixture*

## CHARACTERISTICS

### COLLECTOR SUPPLY

**Modes/Polarity —** Norm: Ac (at line frequency); positive or negative full-wave rectified ac. Dc: Positive or negative dc. Leakage: Emitter current rather than collector current measurements. 1000X increase in vertical deflection sensitivity (1 nA/div).

**Voltages*[1]**

| Range | 15 V | 75 V | 350 V | 1500 V |
|---|---|---|---|---|
| Max Continuous Peak Current | 10 A | 2 A | 0.5 A | 0.1 A |
| Peak Pulse Current | ⩾20 A | ⩾4 A | ⩾1 A | ⩾0.2 A |

*[1] *Peak open circuit voltages within +35% and −5% of indicated range.*

**Series Resistance —** From 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak Power Limit Setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

**Safety Interlock —** Protects operator from dangerous voltages.

### STEP GENERATOR

**Current Mode —** Step/Offset Amplitude Range: 5 nA/step (with X0.1 Mult) to 200 mA/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 amplitude setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 10 V. Maximum Opposing Offset Current: X10 amplitude setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 3 V.

**Voltage Mode —** Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): X20 amplitude switch setting, 40 V maximum. Maximum Current (Steps and Aiding Offset): At least 2 A at 10 V, derating to 10 mA at 40 V. Short Circuit Current Limiting: 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Maximum Opposing Offset Voltage: X10 amplitude setting. Maximum Opposing Current: Limited between 5 mA and 20 mA.

**Accuracy —** Incremental: Within 5%, between steps, within 10% with X1.0 Mult. Absolute: Within 2% of total output including offset, or 1% of amplitude setting, whichever is greater. Offset Multiplier: Continuously variable from 0 to X10 the amplitude setting, either aiding or opposing the step polarity.

**Step Rates —** Selectable at X1, X2 or X4 line frequency.

**Pulsed Steps —** ≈80 μs or 300 μs width.

**Step/Offset Polarity —** Same as Collector Supply polarity and positive in ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

**Step Family —** Repetitive or single family.

**Number of Steps —** Selectable from 1 to 10.

**Vertical Deflection Factor —** Collector Current: 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter Current: 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step Generator: 1 step/div.

**Horizontal Deflection Factor —** Collector Volts: 50 mV/div to 200 V/div, 12 steps (5 mV/div with X10 magnification). Base Volts: 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step Generator: 1 step/div.

## DEFLECTION CONTROLS

**Display Accuracies*[1]**

| Display Modes | | Offset and Magnified with Centerline Value from: | | |
|---|---|---|---|---|
| **Normal and Dc Modes** | **Normal (unmagnified)** | **100-40 div** | **35-15 div** | **10-0 div** |
| Vertical Collector Current | 3% | 2% | 3% | 4% |
| Horizontal Collector Volts | 3% | 2% | 3% | 4% |
| Horizontal Base Volts | 3% | 2% | 3% | 4% |
| **Leakage Mode** | | | | |
| Vertical Emitter Current | | | | |
| 10 nA/div to 2 mA/div | 3% ± 1 nA | NOT APPLICABLE | | |
| 1 nA/div to 200 μA/div | — | 2% ± 1 nA | 3% ± 1 nA | 4% ± 1 nA |
| 5 nA/div, 2 nA/div, 1 nA/div | 5% ± 1 nA | NOT APPLICABLE | | |
| Horizontal Collector Base Volts w/ Emitter Current of: | | | | |
| ⩾1 μA/div | 3% | 2% | 3% | 4% |
| 100 nA/div, 10 nA/div, 1 nA/div | 3% + 25 mV/ Vert div | NOT APPLICABLE | | |
| 200 nA/div, 20 nA/div, 2 nA/div | 3% + 50 mV/ Vert div | NOT APPLICABLE | | |
| 500 nA/div, 50 nA/div, 5 nA/div | 3% + 125 mV/ Verti div | NOT APPLICABLE | | |
| **Step Generator Mode** | | | | |
| Vertical | 4% | 3% | 4% | 5% |
| Horizontal | 4% | 3% | 4% | 5% |

*[1] *As a percentage of highest on-screen value .*

**Displayed Noise*[1]**

| Range | 15 V | 75 V | 350 V | 1500 V |
|---|---|---|---|---|
| Vert Collector | 1 μA | 1 μA | 2 μA | 5 μA |
| Vert Emitter | 1 nA | 1 nA | 1 nA | 5 nA |
| Horiz Base | 5 mV | 5 mV | 5 mV | 5 mV |
| Horiz Collector | 5 mV | 5 mV | 20 mV | 200 mV |

*[1] *1% or less, or the values shown.*

**Position Controls —** Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

**Display Offset —** 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 Magnifier.

### CRT

**CRT —** 165 mm (6.5 in) rectangular with 10 cm x 10 cm division (12 cm usable horizontal) parallax-free, illuminated graticule GH (P31) phosphor standard. Accelerating potential is 4.0 kV.

**Readout —** The readouts, adjacent to CRT, are digital indicators of the following parameters: Per Vert Div from 1 nA/div to 2 A/div; Per Horiz Div from 5 mV/div to 200 V/div; Per Step from 5 nA/step to 2 A/step, 5 mV/step to 2 V/step; $\beta$ (Beta) or $g_m$, Per Div from 1 μ to 500 k calculated from Current/Div, X10 Mag, Step Amplitude, and X0.1 Mult.

## POWER REQUIREMENTS

**Voltage Ranges —** 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions).

**Line Frequency —** 48 Hz to 66 Hz.

**Maximum Power Consumption (Including DUT Power) —** 305 W. Standby Power: ≈60 W.

## ENVIRONMENTAL AND SAFETY

**Ambient Temperature —** Operating: +10°C to +40°C. Nonoperating: −40°C to +65°C.

**Altitude —** Operating: To 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration —** Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Shock —** Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shots.

**Safety —** CSA Certified (CSA 556 B).

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 299 | 11.8 |
| Height | 381 | 15.0 |
| Depth | 591 | 23.3 |
| **Weights** | **kg** | **lb** |
| Net | 32.0 | 70.5 |
| Shipping ≈ | 48.5 | 107.0 |

## STANDARD TEST FIXTURE (650-0459-01)

**Description —** A plug-in fixture with two sets of five pin test terminals, the Emitter Grounded or Base Grounded switch, Left-Off-Right switch, Step Gen Output, Ext Base or Emitter input, and the Safety Shield. The test terminals accept either the six pin universal adaptors, three pin adaptors, or the high-power transistor adaptors with Kelvin contacts.

## ORDERING INFORMATION

**576** Curve Tracer with Standard Test Fixture **$12,420**

**Includes:** Standard test fixture (650-0459-01); transistor adaptor (013-0098-02); FET adaptor (013-0099-02); TO3 adaptor (013-0100-01); TO66 adaptor (013-0101-00); axial lead diode adaptor (013-0111-00); stud diode adaptor (013-0110-00); Kelvin sensors for large and small plastic transistors (013-0138-01); safety shield (337-1194-01); power cord (161-0066-00); instruction manual (070-0905-01).

### OPTIONS

**Option 01 —** Deletes the auto scale-factor readout module but maintains provisions for insertion of the module (020-0031-00) at any time. **−$960**

### CONVERSION KIT

**Auto Scale-Factor Readout Module —** Order 020-0031-00 **$1,650**

### INTERNATIONAL POWER PLUG OPTIONS

**Option A1 —** Universal Euro 220 V/16 A, 50 Hz.
**Option A2 —** UK 240 V/13 A, 50 Hz.
**Option A3 —** Australian 240 V/10 A, 50 Hz.
**Option A4 —** North American 240 V/15 A, 60 Hz.
**Option A5 —** Switzerland 220 V/10 A, 50 Hz.

## OPTIONAL ACCESSORIES

**Test Setup Chart —** Package of 250. Order 070-0970-01 **$10**
**172 —** Test Fixture. See page 396. **$5,225**
**176 —** Test Fixture. See page 397. **$5,760**
**Socket Adaptors —** See page 401.
**Camera —** C-59A and adaptor. (See page 415.) **$1,335**
**Cart —** K217. See page 424. **$495**

# 172

**Semiautomated Test Fixture**

**Tests Up to 11 Parameters**

**Reduces Total Test Time**

## TYPICAL APPLICATIONS

* **Production Device Testing**
* **Incoming Inspection**

The 172 Programmable Test Fixture, when used with the Tektronix 576 Curve Tracer, permits the operator to quickly perform a sequence of tests on FETs, transistors, and diodes.

The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172, all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable rate control is provided to set the test sequence at a rate which is best for the operator. New operators require more time per test, but with experience they will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

| TESTS THAT CAN BE PERFORMED ON: | | | | PROGRAMMABLE CAPABILITIES |
|---|---|---|---|---|
| Test | Xstr | FETs | Diodes | |
| 1*[1] | $H_{FE}$<br>$V_{CE}^{(sat)}$ | $V_P$ | $V_F$ | Peak Current up to 10 A, Peak Volts up to 350 V. |
| 2 | $V_{BE}$ | | | Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1). |
| 3 | $H_{FE}$,<br>$V_{CE}^{(sat)}$ | $I_{DSS}$,<br>$R_{DS}^{(on)}$ | | Base Drive: 100 nA to 110 mA. When testing FETs the base terminal is shorted to the emitter terminal.<br>Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively. |
| 4 | Same as #3 | | | |
| 5 | $I_{CEO}$ or $I_{CES}$,<br>$I_{CER}$ with external short or resistor | | | Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 A.<br>The most sensitive deflection factor is 1 nA/div. |
| 6 | $I_{CBO}$ | $I_{GSS}$ | | Same as #5 |
| 7 | $I_{EBO}$ | | $I_R$ | Same as #5 |
| 8 | $V_{(BR)CEO}$ or<br>$V_{(BR)CER}$ with external resistor | | $V_F$ | Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 110 mA dc for breakdown voltage measurements to 50 V. |
| 9 | $V_{(BR)CES}$ | $BV_{GSS}$ | | Same as #8. |
| 10 | $V_{(BR)CBO}$ | $BV_{GSS}$: | | Same as #8. |
| 11 | $V_{(BR)EBO}$ | | $V_R$ | Same as #8. |

*[1] *All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.*

*For the remaining test the only 576 controls that are functional are the Polarity and CRT controls such as Intensity, Focus, Display Offset.*

## CHARACTERISTICS

### VERTICAL AND HORIZONTAL AMPLIFIERS

**Display Accuracies —** The same as the 576 Curve Tracer with its included Standard Test Fixture.

**Vertical Deflection Factor —** Tests 1 and 2 (Collector or Emitter Current): 1 μA to 2 A/div in 20/steps. Tests 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA to 0.5 A/div in 18 steps. Tests 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1-2-5 sequence.

**Horizontal Deflection Factor —** Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for Test 2: At least 100 MΩ at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Tests 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1-2-5 sequence.

**Collector Sweep Voltage —** At least 2 V open circuit, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

**Current Supply Accuracy —** 0.1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ±30 nA with up to 50 V compliance. Increments of Current Are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA), 100 μA (from 1 mA to 11 mA) and 1 mA (from 10 mA to 110 mA).

**Voltage Supply Accuracy —** 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

**Test Display Time Range (Automatic) —** 400 ms to 1.5 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

### ENVIRONMENTAL

**Ambient Temperature —** Operating: +10°C to +40°C. Nonoperating: −40°C to +65°C.

**Altitude —** Operating: 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration —** Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minute at 50 Hz.

**Shock —** Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 200 | 7.9 |
| Height w/shield | 165 | 6.5 |
| Depth | 315 | 12.4 |
| **Weights** | **kg** | **lb** |
| Net | 5.2 | 11.5 |
| Shipping ≈ | 8.2 | 18.0 |

## ORDERING INFORMATION

**172** Programmable Test Fixture **$5,225**

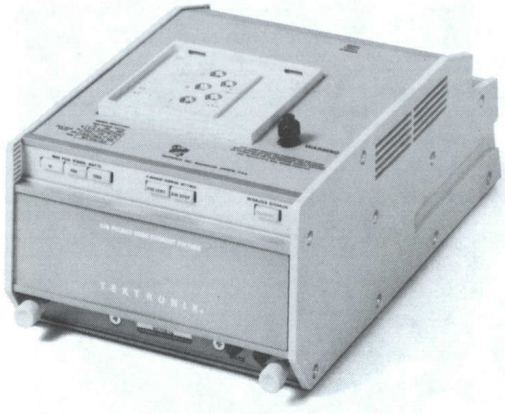
**Includes:** Safety shield (337-1194-01); five programming cards (016-0198-00); 250 programming card pins (214-1633-00); five CRT overlay limit cards (016-0510-00); instruction manual (070-1170-01).

# 176

**Tests High Power Devices**

**Tests Up to 200 Amps in Pulsed Mode**

**1000 Watt Capability**



The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. When selected, the step offset is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the step generator in regard to width and repetition rate.

The pulse width is selected by pressing the 300 μs or 80 μs pushbutton on the 576 mainframe. The repetition rate is automatically set when the 176 is inserted in the mainframe. Repetition rate is also dependent on power-line frequency. The five highest Vertical Current/Division settings (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 Vert pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest Step Generator Amplitude base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 Step pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 Vert and X10 Step pushbuttons provide inputs to the fiberoptic readout in the 576 to display actual values.

## CHARACTERISTICS

### COLLECTOR SUPPLY (PULSED)

**Width** — 300 μs or 80 μs determined by 576.

**Repetition Rate** — Power-line frequency.

**Polarity** — + or − determined by 576 polarity control.

**Amplitude** — Ranges: 15 V, 75 V, 350 V nominal, controlled by Max Peak Volts switch on 576. Current (minimum available at low line into shorted load): 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.

**Maximum Peak Watts** — Three illuminated pushbuttons select 10 W, 100 W, 1000 W maximum peak power.

### STEP GENERATOR

**Current Ranges (X10 Step Selected)** — Step/Offset Amplitude Range: 100 mA to 2 A, 5 steps, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): 200 x 576 Amplitude setting or 20 A, whichever is less. Maximum Voltage (Steps and Aiding Offset): At least 5 V up to 10 A and 2 V up to 20 A.

**Accuracy (Current Steps Including Offset)** — Incremental: Within 5% between any two steps; within 10% with X0.1 Step Mult. Absolute: Within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.

**576 Offset Multiplier** — 0 to 100 x 576 Amplitude switch setting.

**Step Rate** — Power-line frequency.

**Pulsed Steps** — 300 μs or 80 μs wide.

**Step/Offset Polarity** — Same as Collector Supply polarity. Polarity can be independently inverted with Step/Offset Polarity control.

### VERTICAL AMPLIFIER

**Deflection Factor (X10 Vert Selected)** — 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

### ENVIRONMENTAL

**Ambient Temperature** — Operating: +0°C to +40°C. Nonoperating: −40°C to +65°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 200 | 7.9 |
| Height w/shield | 196 | 7.7 |
| Depth | 290 | 11.4 |
| **Weights** | **kg** | **lb** |
| Net | 5.8 | 12.8 |
| Shipping ≈ | 8.2 | 18.0 |

## ORDERING INFORMATION

**176** Pulsed High-Current Fixture **$5,760**

**Includes:** TO36 adaptor (013-0112-00); stud diode adaptor (013-0110-00); safety shield (337-1194-01); instruction manual (070-1073-00).

# 577/177

**Test Two-Terminal and Three-Terminal Discrete Semiconductors**

**Storage Capability (Option 10)**

**Power Capability Up to 100 Watts**

## TYPICAL APPLICATIONS

* **Incoming Inspection**
* **Semiconductor R & D**

*177 Standard Test Fixture*

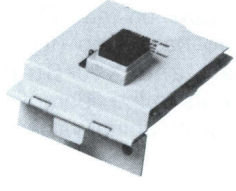
The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are a storage CRT (optional) and the emphasis on low current measurements with the 577.

The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op amp testing because the open-loop, 3 dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see page 400).

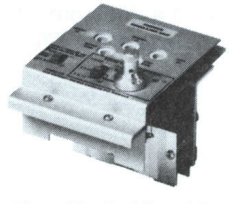
In the 577/177 Curve Tracer System, several features facilitate low current measurements. They include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three-terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available; 10 amps continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

*178 Linear IC Test Fixture*



*Standard Op Amp Card for 178 Test Fixture*



*Three-Terminal Regulator Card for 178 Test Fixture*

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

A safety interlock protects the operator from dangerous voltages. For collector voltages greater than 15 V, a plastic protective safety shield must be in place over the test terminals and its lid closed before collector voltage can be applied.

## CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

### COLLECTOR SUPPLY

**Modes/Polarity** — Norm: Ac (at line frequency); positive or negative full-wave rectified ac. Dc: Positive or negative dc.

**Voltage*[1]**

| Range | 6.5 V | 25 V | 100 V | 400 V | 1600 V |
|---|---|---|---|---|---|
| Max Continuous Peak Current | 10 A | 2.5 A | 0.6 A | 0.15 A | 0.04 A |
| Peak Pulse Current | 20 A | 5 A | 1.25 A | 0.30 A | 0.08 A |

*[1] *Peak open circuit voltages within +35% and −5% of indicated range.*

**Series Resistance** — From 0.12 Ω to 8 MΩ in 14 steps, all within 15%, ±0.1 Ω. Peak Power Limit Setting: 100 W, 30 W, 9 W, 2.3 W, 0.6 W, 0.15 W.

**Safety Interlock** — Protects operator from dangerous voltages.

### STEP GENERATOR

**Current Mode** — Step/Offset Amplitude Range: 5 nA/step (with X0.1 Mult) to 200 mA/step, 1-2-5 sequence. Maximum Current (Steps and Aiding Offset): X20 amplitude setting, except X10 (2A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum Voltage (Steps and Aiding Offset): At least 7 V. Maximum Opposing Offset Current: X10 amplitude setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 5 V.

**Voltage Mode** — Step/Offset Amplitude Range: 5 mV/step (with X0.1 Mult) to 2 V/step, 1-2-5 sequence. Maximum Voltage (Steps and Aiding Offset): 20 times amplitude switch setting. Maximum Current: At least 100 mA at 0 V. Short Circuit Current Limiting: Not more than 200 mA. Maximum Opposing Offset Voltage: X10 amplitude switch setting. Maximum Opposing Current: Limited between 10 mA and 20 mA (derating to 0 mA at 20 V).

**Accuracy** — Incremental: Within 2% between steps. Absolute: Within 3% of total output or amplitude setting, whichever is greater. Within 4% with X.01 mult. Offset Multiplier: Continuously variable from 0 to X10 the amplitude setting, either aiding or opposing the step polarity.

**Step Rates** — Selectable at X1, X2, or X4 line frequency.

**Pulsed Steps** — ≈300 μs width.

**Step/Offset Polarity** — Same as Collector Supply polarity and positive in the ac position. Polarity can be independently inverted with Step/Offset Polarity control or from the test fixture.

**Step Family** — Repetitive or single family.

**Number of Steps** — Selectable from 1 to 10 full-amplitude steps. Selectable up to ≈95 steps when using Step X0.1 multiplier.

### DEFLECTION CONTROLS

**Display Accuracies*[1]**

| Display Mode | Normal (unmagnified) | Magnified |
|---|---|---|
| **Norm and Dc Modes** | | |
| Vertical Collector Current | 3% ± 1 nA | 4% ± 1 nA |
| Horizontal Collector Volts | 3% | 4% |
| Horizontal Base Volts | 3% | 4% |
| **Step Generator Mode** Horizontal Mode | 4% | 5% |

*[1] *As a percentage of highest on-screen value.*

**Vertical Deflection Factor** — Collector Current: 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

**Horizontal Deflection Factor** — Collector Volts: 50 mV/div to 200 V/div, 12 steps in 1-2-5 sequence (5 mV/div to 20 V div with X10 magnification). Base Volts: −50 mV/div to 2 V/div, 6 steps in 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification). Step Generator: 1 step/div (0.1 step/div with X10 magnification).

**Displayed Noise*[1]**

| Range | 6.5 V | 25 V | 100 V | 400 V | 1600 V |
|---|---|---|---|---|---|
| Vert Collector | 0.5 nA | 2.5 nA | 8 nA | 20 nA | 50 nA |
| Vert Emitter | 0.5 nA | 2.5 nA | 8 nA | 20 nA | 50 nA |
| Horiz Base | 5 mV | 5 mV | 5 mV | 5 mV | 5 mV |
| Horiz Collector | 5 mV | 5 mV | — | — | — |

**Automatic Scale Factor Readout** — Change in deflection factor is indicated by lights behind the knob skirt when using X10 Mag.

**Automatic Positioning** — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

**Display Invert** — Single control inverts display and repositions trace.

**Display Filter** — Selectable low-pass filter reduces vertical noise for easier high sensitivity measurements.

### CRT

**CRT** — Rectangular 165 mm (6.5 in) with an 8 x 10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to GJ (P1). The D2 display unit has a nonstorage CRT with GH (P31) phosphor standard. Accelerating potential is 3.5 kV.

**Beam Finder** — Compresses off-screen trace to within graticule area.

### POWER REQUIREMENTS

**Line Voltage Ranges (±10%)** — 100 V ac, 110 V ac, 120 V ac or 200 V ac, 220 V ac, 240 V ac.

**Line Frequency** — 50 Hz to 60 Hz.

**Power** — 155 W max at 110 V ac, 60 Hz.

### ENVIRONMENTAL AND SAFETY

**Ambient Temperature** — Operating: +10°C to +40°C. Nonoperating: −40°C to +65°C.

**Altitude** — Operating: To 3000 m (10,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**Safety** — CSA certified (CSA 556 B).

### PHYSICAL CHARACTERISTICS

| | 577 | | 177 | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 224 | 8.8 | 201 | 7.9 |
| Height | 503 | 19.8 | 102 | 4.0 |
| Depth | 584 | 23.0 | 152 | 6.0 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 18.1 | 40.0 | 1.1 | 2.5 |
| Shipping ≈ | 22.7 | 50.0 | 2.7 | 6.0 |

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≈24 kg or ≈53 lb.

## 177 Standard Test Fixture

### CHARACTERISTICS

**Device Lead Selection** — Switch provides six different lead configurations. Three positions for Emitter Grounded measurements provide Step Gen, Open (or Ext), and Short base terminal connections. Two positions for Base Grounded measurements provide Step Gen and Open (or Ext) emitter terminal connections. One position provides for Emitter Base Breakdown or leakage measurements up to 25 Volts.

**Left-Right Switch** — Selects left or right test connections. Off in center position. Test connection area accepts all Tektronix Curve Tracer adaptors and protective cover. Kelvin connections are provided for emitter and collector terminals.

**Looping Compensation** — Reduces display loops due to test adaptor capacitance and some device capacitance.

**Variable Voltage Supply** — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

## ORDERING INFORMATION

**577/D1** Storage Curve Tracer Mainframe (w/o Test Fixture) **$6,750**
**Includes:** Transistor adaptor for most bipolar transistors and some MOS FETs (013-0098-02); axial lead diode adaptor with Kelvin sensing terminals (013-0111-00); safety shield for test connection area (337-1194-01); instruction manual (070-1436-00).

**577/D2** Nonstorage Curve Tracer Mainframe (w/o Test Fixture) **$5,835**
**Includes:** Same as 577/D1.

**OPTIONS**

**Option 10** — 10 cm x 10 cm graticule. **+$95**

**TEST FIXTURES**

**177** — Standard Test Fixture **$1,390**

**178** — Linear Test Fixture. (See next page.) **$3,475**

**OPTIONAL ACCESSORIES**

**Test Setup Chart** — Package of 250. Order 070-1639-00 **$7.50**

**Device Adaptor Sockets** — (See page 401.)

**Camera** — C-5C. (See page 416). **$495**

**Cart** — K213. (See page 424). **$595**

# 178

**Tests Single, Dual, or Quad:**
**Operational Amplifiers, Comparators**
**Differential Amplifiers, Regulators and More**

Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary and accurate low-current measurement capability. Test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adaptor that interfaces the system to the device under test.

Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

## OP AMP CARDS

The Standard Op Amp Card is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, CMRR, gain, positive and negative PSRR, positive and negative supply current, and collector supply current.

The Hardwire Card is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device under test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The Multiple Op Amp Card allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

### Socket Adaptors for Op Amp Cards

The device-under-test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adaptors using the Amphenol-Barnes Adaptor System. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on the next page.

## REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

### Socket Adaptors for Regulator Cards

Socket adaptors for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adaptors used on the standard curve tracer. (See next page.)

# CHARACTERISTICS

## VERTICAL AMPLIFIER

**Display Accuracies/Deflection Factor**

| Vertical*1 | Normal | Magnified |
|---|---|---|
| Input Voltage or ΔInput Voltage | 10 μV/div to 50 mV/div | 1 μV/div to 5 mV/div |
| Accuracy*2 | 3% | 4% |
| Input Current | 50 pA/div to 0.2 mA/div | 5 pA/div to 20 μA/div |
| Accuracy*2 | 3% ±50 pA | 4% ±50 pA |
| Power Supply Current | 0.1 μA/div to 50 mA/div | 10 nA/div to 5 mA/div |
| Accuracy*2 | 3% ±0.1 μA | 4% ±0.1 μA |
| Collector Supply Current | 1 nA/div to 50 mA/div | 0.1 nA/div to 5 mA/div |
| Accuracy*2 | 3% ±1 nA | 4% ±1 nA |

*1 *1-2-5 sequence.*
*2 *Percentage of highest on-screen values.*

## POWER SUPPLIES

**Voltage —** Positive and negative supplies are adjustable from 0 V to 30 V. Voltage of both supplies can be adjusted from a single calibrated control. Accuracy is within 2% ± 100 mV. Negative supply can be independently adjusted by an uncalibrated control.

**Current —** At least 150 mA with adjustable current limiting.

## SWEEP GENERATOR

**Frequency Range —** Adjustable from 0.01 Hz to 1 kHz. Sinusoidal signal controls output, common-mode input, or power supply voltages of device under test.

**Amplitude —** Adjustable from 0 V to 30 V peak.

## SOURCE RESISTANCE

**Resistor Values —** Two each, 50 Ω, 10 kΩ, 20 kΩ, 50 kΩ, or external resistors. When vertical deflection factor is in 1 mV through 50 mV/div position, add 550 Ω to all values.

## LOAD RESISTANCE

**Resistor Values —** One each, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, 50 kΩ, or external resistors.

## OTHER CHARACTERISTICS

**DUT Supplies Disconnect —** A single switch disconnects all power to the device under test; both plus and minus power supplies, collector supply, and step generator.

**Function Switch —** Selects vertical and horizontal deflection signals and connection of the test signal to the device under test.

**Zero —** Single pushbutton provides a zero reference to the CRT display and in certain functions, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

## COLLECTOR SUPPLY

The 25 V and 100 V ranges of the collector supply (located on 577 mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for collector supply performance.)

## STEP GENERATOR

All the capabilities of the step generator (located on 577 mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for step generator performance.)

## THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

**Device Under Test Input Supply —** Input Voltage (Two Ranges): 0 V to 30 V is within 2% ±200 mV of dial setting. 0 V to 60 V is within 2.5% ±300 mV of dial setting.
Regulation: Within 200 mV.
Input Sweep Frequency: Dc to 1 kHz.
300 μs Pulsed Current: 5 mA to 2 A.

**Short Duration Dc Current*1**

| Supply Voltage | Current |
|---|---|
| 0 to 10 | 700 mA |
| 10 to 20 | 350 mA |
| 20 to 40 | 350 mA |
| 40 to 60 | 120 mA |

*1 *One minute duration.*

**Device-Under-Test Current Load —** 5 mA to 2 A within ±3%, ±1.25 mA.

**Device-Under-Test Comparison Output Dc Voltage Accuracy —** 0 V to 10 V Range: Within 1% ±20 mV. 0 V to 100 V Range: Within 1% ±150 mV.

## PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 201 | 7.9 |
| Height | 114 | 4.5 |
| Depth | 198 | 7.8 |
| **Weights** | **kg** | **lb** |
| Net | 1.5 | 3.3 |
| Shipping ≈ | 3.6 | 8.0 |

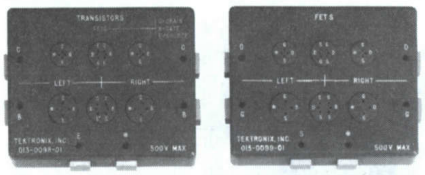
# ORDERING INFORMATION

**178** Linear IC Test Fixture **$3,475**

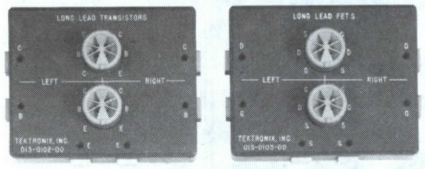
**Includes:** 16 DIP IC sockets (136-0442-00); standard Op Amp Card with cover and ten patch cords (013-0149-02); interchangeable nomenclature panel for function switch (333-1770-00); instruction manual (070-1977-00).

## OPTIONAL ACCESSORIES

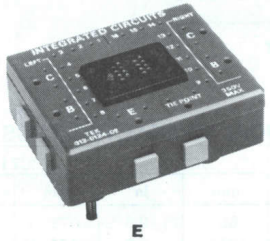
**Standard Op Amp Card —** One included with 178. Order 013-0149-02 **$165**
**Hardwire Card —** Order 013-0150-02 **$110**
**Multiple Op Amp Card —** Order 013-0155-01 **$580**
**Positive Regulator Card —** Order 013-0147-00 **$995**
**Negative Regulator Card —** Order 013-0148-00 **$995**
**2 Inch Patch Cord —** Package of 10. Order 012-0200-00. **$4.50**




A B




C D




E

## DUAL WIDTH ADAPTORS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

**A. Transistor Adaptor** — Useful for most single and dual bipolar transistors and some MOS FETs. Order 013-0098-02 **$230**

**B. FET Adaptor** — Useful for most single and dual FETs. Order 013-0099-02 **$230**

**C. Long Lead Transistor Adaptor** — Accepts dual or single transistors with untrimmed leads. Order 013-0102-00 **$205**

**D. Long Lead FET Adaptor** — Accepts dual or single FETs with untrimmed leads. Order 013-0103-00 **$230**

**E. Integrated Circuit Adaptor** — Allows connection to multipin device packages. The appropriate multilead socket is plugged into the integrated circuits adaptor. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Order the appropriate multilead socket listed separately. Includes ten each 4 inch test leads (012-0310-00). Order 013-0124-03. **$415**

A B C

D E F

G H I

## KELVIN SENSING ADAPTORS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

**A. Transistor Adaptor** — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations. Order 013-0127-01 **$85**

**B. In-Line Adaptor** — Accepts large and small transistors with in-line leads. The adaptor will accept devices with approx spacing between terminals of 0.06 in up to 0.18 in. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order 013-0138-01 **$100**

**C. TO36 Adaptor** — Order 013-0112-00 **$100**

**D. TO3 Adaptor** — Can be rewired to accommodate nonstandard configurations. Order 013-0100-01 **$115**

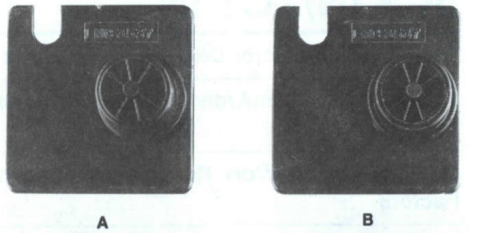
**E. TO66 Adaptor** — Order 013-0101-00 **$115**

**F. Axial Lead Diode Adaptor** —
Order 013-0111-00 **$105**

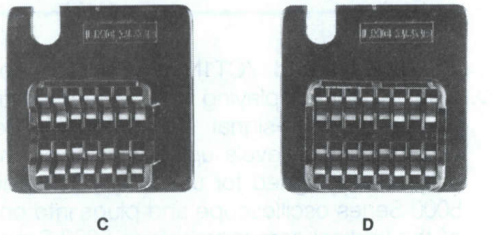
**G. Stud Diode Adaptor** —
Order 013-0110-00 **$100**

**H. Blank Adaptor** — For mounting special sockets. Order 013-0104-00 **$60**

**I. Power Transistor Adaptor** —
Order 013-0163-00 **$120**



A B



C D

## MULTILEAD SOCKETS

These sockets are used with the Integrated Circuit Adaptor (013-0124-03) listed under Dual Width Adaptors, and with the 178 Test Fixture.

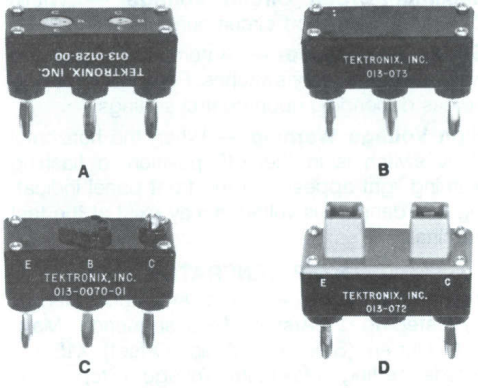
**A. 8 Lead TO Package** —
Order 136-0444-00 **$39**

**B. 10 Lead TO Package** —
Order 136-0441-00 **$46**

**C. 14 Lead Dual-in-line Package** —
Order 136-0443-00 **$46**

**D. 16 Lead Dual-in-line Package** —
Order 136-0442-00 **$44**

These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.




A B C D

## 3-PIN ADAPTORS

The following 3-pin adaptors may be used with any of the Tektronix curve tracer products. They do not have Kelvin sensing contacts.

**A. TO5 or TO18** — Transistor Adaptor. Order 013-0128-00 **$40**

**B. Blank Adaptor** — For mounting special sockets. Order 013-0073-00 **$19**

**C. TO3 or TO66** — Transistor Adaptor. Order 013-0070-01 **$44**

**D. Diode Test Adaptor** — Holds axial-lead diodes. Order 013-0072-00 **$92**

# 5CT1N/7CT1N

**Tests Semiconductor Devices to 0.5 Watts**

**10 nA/div to 20 mA/div Vertical Deflection Factors**

**0.5 V/div to 20 V/div Horizontal Deflection Factors**

**Easy to Operate**

The 5CT1N and 7CT1N are oscilloscope plug-ins for displaying the characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The 5CT1N is designed for use in any Tektronix 5000 Series oscilloscope and plugs into one of the vertical compartments (a 5000 Series amplifier or time base must be installed in the horizontal compartment). The 7CT1N is designed for use in any Tektronix 7000 Series oscilloscope and plugs into either a vertical or horizontal compartment (a 7000 Series amplifier or time base must be installed in the corresponding horizontal or vertical compartment).

## CHARACTERISTICS

### COLLECTOR/DRAIN SUPPLY

| | X1 | | X10 | |
|---|---|---|---|---|
| Horizontal Volts/Div | 0.5 | 2 | 5 | 20 |
| Voltage Range | 0 to 7.5 V | 0 to 30 V | 0 to 75 V | 0 to 300 V |
| Maximum Current | 240 mA | 60 mA | 24 mA | 6 mA |

**Maximum Open Circuit Voltage** — Within 20%. Maximum short circuit current within 30%.

**Series Resistance** — Automatically selected with horizontal V/div switches. Peak Power: 0.5 W or less depending upon control settings.

**High Voltage Warning** — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

### STEP GENERATOR

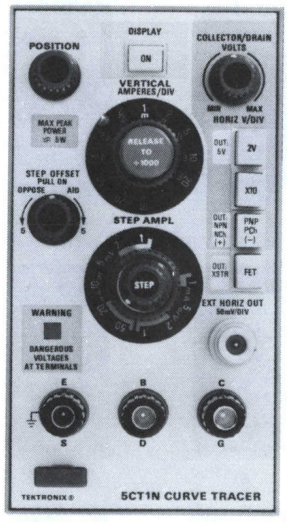
**Transistor Mode** — Step Amplitude Range: 1 μA/step to 1 mA/step, 1-2-5 sequence. Maximum Current (Steps Plus Aiding Offset): X15 amplitude setting. Maximum Voltage (Steps Plus Aiding Offset): At least 13 V. Maximum Opposing Offset Current: At least X5 amplitude setting.

**FET Mode** — Step Amplitude Range: 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage Amplitude (Steps Plus Aiding Offset): X15 amplitude setting, 13 V maximum. Source Impedance: 1 kΩ ± 1%.

**Accuracy** — Incremental: Within 3% between steps. Absolute: Within (3% + X0.3 amplitude setting).

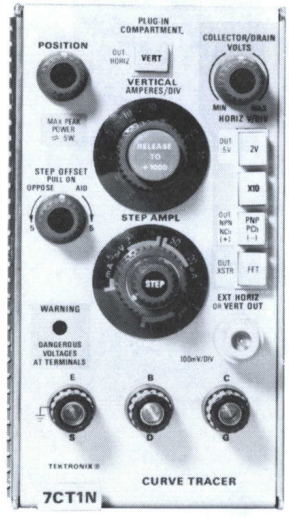
**Step Polarity** — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

5CT1N




**Curve Tracer**

7CT1N




**Curve Tracer**

**Number of Steps** — Selectable in one-step increments between 0 and 10.

**Offset** — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

**Vertical Deflection Factors** — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

**Vertical Display Accuracy** — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷1000 mode.

**Horizontal Deflection Factors** — Selectable, 0.5 V, 2 V, 5 V, or 20 V.

**5CT1N Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 5000 Series plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 5000 Series oscilloscope mainframe.

**7CT1N Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 7000 Series plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of a 7000 Series oscilloscope mainframe.

### ENVIRONMENTAL CHARACTERISTICS

**Shock** — Nonoperating: 30 g's, ½ sine, 11 ms duration in each direction along each major axis. Total of six shocks.

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: 5000 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three major axes. 0.04 cm (0.015 in) p-p displacement 10 Hz to 50 Hz to 10 Hz in one minute cycles. Held for three minutes at 50 Hz.

### PHYSICAL CHARACTERISTICS

| | 5CT1N | | 7CT1N | |
|---|---|---|---|---|
| **Dimensions** | **mm** | **in** | **mm** | **in** |
| Width | 66 | 2.6 | 71 | 2.8 |
| Height | 127 | 5.0 | 127 | 5.0 |
| Depth | 305 | 12.0 | 368 | 14.5 |
| **Weights** | **kg** | **lb** | **kg** | **lb** |
| Net | 0.8 | 1.8 | 1.1 | 2.5 |
| Shipping ≈ | 1.8 | 4.0 | 2.7 | 6.0 |

## ORDERING INFORMATION

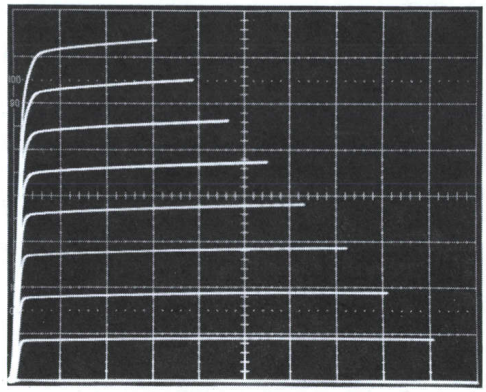
**5CT1N** Curve Tracer **$1,050**

**Includes:** Test adaptor with two sets of test terminals, one with TO5 basing and the other with TO18 basing (013-0128-00); instruction manual (070-1246-00).

**7CT1N** Curve Tracer **$1,740**

**Includes:** Same as 5CT1N but with instruction manual 070-1247-00.

See 3-pin adaptors on preceding page.



*2N3904 transistor characteristic generated by the 7CTIN. Control Settings are indicated on front panel of 7CTIN. Vertical: 2 mA/div. Horizontal: 0.5 V/div. Base Current: 10 μA/step.*

# ACCESSORIES

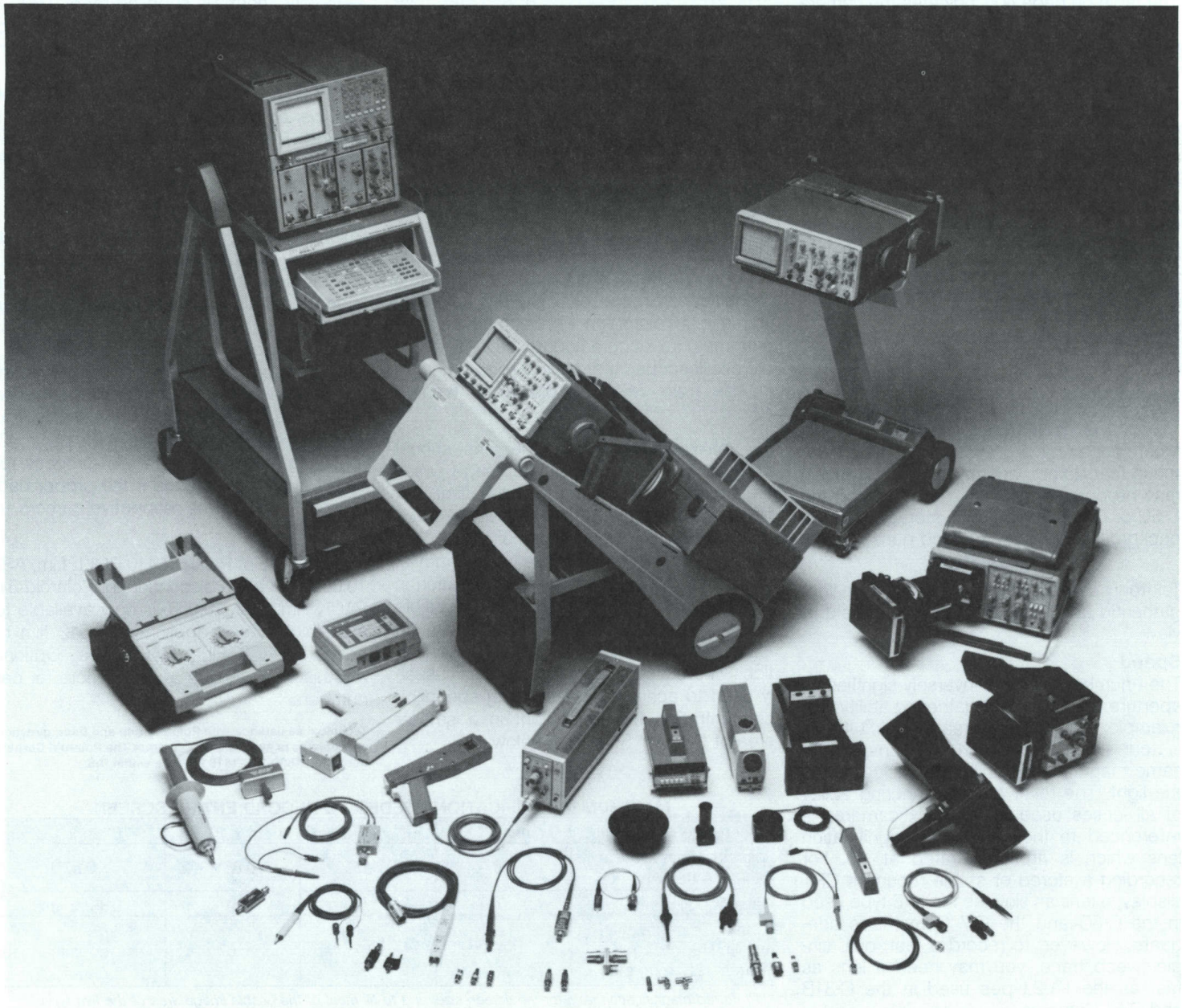
**THE ABCs OF PROBES**

This comprehensive booklet on signal acquisiton probes contains sections on understanding probe specifications and applications and sections on how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature *60W-6053* or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

## CONTENTS


Cameras & Adaptors ..... 404
Digital Photometer/Radiometer ..... 417
Carts ..... 422
Probes ..... 425
Isolation Accessories ..... 436
Probe Accessories ..... 446
Adaptors and Connectors ..... 448
Mounting Accessories ..... 450
Viewing Accessories ..... 451

# CONTENTS


Reference ..... 404
Camera/Adaptor Selection/
Comparison Guides ..... 406, 407
C-4 ..... 408
C-7 ..... 410
C-30 Series ..... 412
C-50 Series ..... 413
C-59A ..... 414
C-5C ..... 416


A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

## MOUNTING ADAPTORS

The table on page 406 indicates the camera adaptors required for most Tektronix instruments and a few by other manufacturers. In some cases, adaptors are available from Hewlett-Packard or others to mount Tektronix cameras to their instruments.

## VIEWING

The C-30 Series and the C-50 Series are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The light-weight C-5C and C-7 can easily be removed to view the CRT or you can use the viewing door in the flash unit. C-5C's and C-7's without a flash have a large lift-up viewing door in its place. The C-50 Series cameras have an off-axis viewing hood that can accommodate eyeglasses for a comfortable binocular view of the CRT display while excluding ambient light.

## GRATICULE LIGHTING

Most scopes have graticule illumination. For those that do not, an image of the graticule may be obtained by using the flash on the C-5C or C-7 Cameras, or a storage scope's background illumination (flood guns).

## LENSES

Tektronix camera lenses differ mainly in light gathering ability, magnification, and field of view.

### Speed

The f-number of a lens inversely signifies its aperture area and light gathering ability. For example: the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in Tektronix cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C and the C-7 Cameras is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

### Field of View

The description for each camera includes a statement of its field of view; this signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adaptor, camera body, film holder, and the image area of the film. (See "Maximum Magnification" chart on this page.)

### Magnification

The rated magnification of a lens signifies its image-to-object ratio. For example, if a scope has a magnification of 0.85 then for every square centimeter on the CRTs face the camera would record 0.85 square centimeter of image on the film.

Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most Tektronix cameras are designed for use at one lens magnification. One exception is the C-30B Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 cm x 6.3 cm to 8 cm x 10 cm.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 667 pack film which has an image area of 73 mm x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film. See chart below.

## SHUTTERS

Of the two available types of shutters, mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism. Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

## POWER REQUIREMENTS

### C-5C

The C-5C uses four AA alkaline batteries.

### C-7

There are three choices of power with the C-7: battery pack that holds eight AA alkaline batteries; ac power supply; or remote power.

### C-50 Series

The C-51 and C-53 electric shutters require +15 volts, normally supplied by a 7000 Series oscilloscope. An optional battery pack (016-0270-02) is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-59A has internal batteries or uses power from the 7000 Series mainframe.

## FILMS

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types. See table on page 405 for listing of Polaroid films. Wet process, roll, or cut films can be used if the proper back is selected. (See the respective camera for optional backs.)

Manufacture of Polaroid 410 ROLL film, ASA 10,000, has been discontinued. Polaroid 612 PACK film, ASA 20,000, is now available for most high speed applications. 612 film requires a PACK FILM BACK, see "Optional Accessories" section of the camera for part numbers.

**Technical assistance with Polaroid film and back questions or problems is available directly from The Polaroid Corporation. Call 1-800-225-1618 toll free within U.S.**

**MAXIMUM MAGNIFICATION NEEDED TO RECORD ENTIRE SCREEN**

| Screen Size | 5 cm x 6.3 cm | 7.2 cm x 9 cm | 8 cm x 10 cm | 9.76 cm x 12.2 cm |
|---|---|---|---|---|
| Polaroid 3¼ in x 4¼ in pack and roll film | 1.0 | 1.0 | 0.85*[1] | 0.67*[1] |
| 4 in x 5 in films | 1.0 | 1.0 | 1.0 | 0.85 or less |
| 6 cm x 7 cm format roll film (70 mm, 120 mm, 220 mm, etc.) | 1.0 | 0.67 | 0.67 | not recommended |

*[1] *Preferred magnification ratio for the screen size, and to fill most of the usable image area of the film type.*

## FILM BACKS

Depending on your application you can choose from a wide variety of cameras and backs. Backs within a series are interchangeable. (See the specific camera for information on a particular back.)

### STANDARD AND OPTIONAL FILM BACKS AND HOLDERS AVAILABLE FROM TEK

| Tek Modified Polaroid Backs | C-30 Series | C-50 Series | C-4, C-5C, C-7 |
|---|---|---|---|
| 3¼ in x 4¼ in pack | Std on "P" models | Std on "P" models | Noninterchangeable (C-5C & C-4) |
| Roll*1 | Yes*1 | Yes*1 | NA |
| 4 in x 3 in AutoFilm™ | NA | NA | C-7 Only |
| **Graflok-Type*2 Interface** | Optional*2 Back | Std on*2 "G" Models | NA |
| Polaroid 3¼ in x 4¼ in pack holder | Yes | Yes | |
| Polaroid 4 in x 5 in single sheet holder | Yes | Yes | |
| Polaroid 4 in x 5 in pack holder*3 | *3 | *3 | |
| 120 mm roll | Yes | Yes | |
| 70 mm roll | Yes | Yes | |
| 4 in x 5 in cut film holder*4 | *4 | *4 | |

*1 *Polaroid is gradually reducing the number of its roll films. Replacement roll backs are available in limited quantities from Tektronix.*

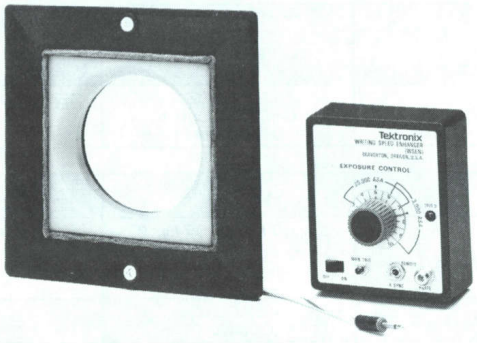
*2 *Requires one of the film holders listed in order to be useable.*

*3 *Will work but available only from Polaroid.*

*4 *Will work but not available from Tek, see your local camera store.*

## PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.




*WSEN (Writing Speed Enhancer) diffuser with control box.*

### Increasing Writing Speed

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The Tektronix Writing Speed Enhancer (WSEN) is designed to fill this need.

The enhancer installs in minutes, and can be triggered in three ways; by a pushbutton on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x-sync switch); or by the oscilloscope-sweep +gate. The WSEN is powered by two 9 V batteries (not included) which are inside the control box.

The film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, postfogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the enhancer with the oscilloscope-sweep +gate.

**For more information on photographing high speed signals request Application Note 42W-5335-1.**

| POLAROID FILM | | RELATIVE FILM WRITING SPEED | |
|---|---|---|---|
| ASA Equivalent Speed | Type | Unfogged | Using a WSEN Fogged |
| 3,000 | 667, 107, 084, 47 | 1 (Reference) | 3*2 |
| 20,000 | 612*1 | >2 | >3.5*2 |

*1 *Polaroid 612 PACK film, ASA 20,000, is now available with faster writing rate than previous 410 ROLL film.*

*2 *Value depends on film, scope, CRT, camera and the operator.*

**The more commonly used Polaroid films for each type of camera back are listed below. Shaded text indicates preferred films.**

| Film Type | ASA Equivalent Speed | Development Time (Seconds at 75°F) | Format | Resolution (Line Pairs/mm) | Characteristics | CRT Recording Uses: Repetitive | Stored | Single Sweep | Video Display (Gray Medical) | Scintillation Type Displays | Color Displays | Scanning Electron Microscope |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3¼ in x 4¼ in PACK FILMS — Actual image area 7.3 cm x 9.5 cm (2⅞ in x 3¾ in), 8 Prints Per Pack** | | | | | | | | | | | | |
| 611*1 | 200 | 45 | Positive Print | 20 | Low Contrast, Wide Gray Scale | | | | ✓ | ✓ | | • |
| 612 | 20,000 | 30 | Positive Print | 20 to 25 | High Contrast | | | ✓ | | | | |
| 665*4 | 75 | 30 | Negative | 160 to 180 | Medium Contrast, Wide Gray Scale | •*4 | •*4 | | •*4 | | | ✓ |
| | | | Positive Print | 14 to 20 | | | | | | | | |
| 107 | 3000 | 15 | Positive Print | 16 to 20 | Medium Contrast | • | • | • | • | | | |
| 084 | 3000 | 15 | Positive Print | 16 to 22 | Medium Contrast | • | ✓ | | • | ✓ | | |
| 667*1 | 3000 | 30 | Positive Print | 11 to 14 | Medium Contrast | ✓ | ✓ | • | • | ✓ | | ✓ |
| 669 | 80 | 60 | Color Positive Print | 11 to 14 | Balanced for Color—Electronic Flash | • | | | • | | ✓ | |
| **AUTOFILM (For C-7 ONLY) — Actual Image Area 10 cm x 7.5 cm (4 in x 3 in), 10 Prints Per Pack** | | | | | | | | | | | | |
| T-331*1*3 *5 | 400 | 60 | Positive Print | 20 | Medium Contrast, Extended Gray Scale | • | • | | ✓ | ✓ | | ✓ |
| T-336*1*6 | 100 | 60 | Negative Transparency | 40 to 100 | Medium Contrast, High Resolution | | | | ✓ | | | • |
| T-339*1*2 | 640 | >60 | Color Positive Print*2 | 7 to 9 | Medium Contrast, High Speed Color | | | | •*2 | | ✓*2 | |
| **SHEET FILMS — Actual Image Area 9.0 cm x 11.4 cm (3½ in x 4½ in)** | | | | | | | | | | | | |
| 55 | | | Positive Print | 22 to 25 | | | | | | | | |
| 55 P/N | 50 | 20 | Negative | 150 to 160 | Medium Contrast, Wide Gray Scale | • | • | | • | | | |
| 57 | 3000 | 15 | Positive Print | 16 to 20 | Medium Contrast | ✓ | ✓ | • | • | | | |
| 552 (8 Pack) | 400 | 20 | Positive Print | 20 to 25 | Medium Contrast | • | • | | ✓ | | | ✓ |

**Polaroid Roll Film Backs are no longer available from Tektronix on new cameras. Polaroid still manufacturers some roll films...Call their toll free number 1-800-225-1618 for film availability.**

✓ *Preferred film for application.*

• *Acceptable performance.*

*1 *No coating required.*

*2 *Requires electronic scan reversal to yield a correct reading image.*

*3 *Similar to Type 611.*

*4 *Allow prints to be made from negative, good for documentation or publications.*

*5 *Available from Tektronix. See page 411.*

*6 *Available in 1986.*

## CAMERA AND MOUNTING ADAPTOR SELECTION GUIDE

**Where two or more cameras are recommended, compare features and specs to optimize for your application.**

| OSCILLOSCOPE OR DISPLAY DEVICE | RECOMMENDED CAMERAS | | | MOUNTING ADAPTOR PART NUMBERS | | | |
|---|---|---|---|---|---|---|---|
| | HIGH WRITING RATE | GENERAL PURPOSE | LOW COST | C-4*11 | C-5C, C-7 | C-51, C-53, C-59A, C-27, C-28 | C-30B*13, C-31B*13 |
| **5000 Series** | | | | | | | |
| 5100 Series Nonstorage*1*3 i.e.; 5110, 5112, D10, D12, 577/D1, 5116 | | C-59A | C-4 Opt 02*11 C-5C; C-7, C-7 Opt 01 | 122-0895-01*11 | 016-0357-01 | 016-0249-06 | Not recommended |
| 5100 Series Storage*1*4 i.e.; 5111, 5111A, 5113, 5115 D11, D13, D15, 577/D2 | | C-59A | C-4 Opt 02*11 C-5C C-7, C-7 Opt 01 | 122-0895-01*11 | 016-0357-01 | 016-0249-06 | Not recommended |
| 5400 Series Nonstorage*1*2 i.e.; 5403/D40, 5440, 5444, D40 | | C-59A | C-4 Opt 02; C-5C; C-7, C-7 Opt 01 | 122-0895-01*11 | 016-0357-01 | 016-0249-06 | Not recommended |
| 5400 Series Storage*2*4 i.e.; 5403/D41, 5441, D41 | C-51 | C-53 | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| 5223*1 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | Not recommended |
| **7000 Series** | | | | | | | |
| 8 cm x 10 cm Display*13 i.e.;7104, 7503, R7103, 7504, 7514, 7613N, 7623, 7633, 7704(A), 7834, 7844, 7854, R7903, 7904, 7904A, T922R*2 | C-51 C-31B Opt 01*10 | C-53 C-30B Opt 01*10 | C-4 Opt 02 C-5C C-5C Opt 01 C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| Large Screen Display i.e.;*1 7403, 7603, 7603N | | C-59A | C-4 Opt 02 C-5C; C-5C Opt 01 C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | Not recommended |
| **Portables*5** | | | | | | | |
| Older with 0.8 cm Graticule i.e.; 422, 453, 454, 485 | C-31B | C-30B | C-4 | 122-0894-01 | No adaptor | No adaptor*5 | 016-0306-01 |
| Newer w/1 cm Graticule i.e.;*7 2235 Option 01; 455, 464, 465, 465B, 465M,466, 468, R468, 475, 475A, 432, 434, 442 | C-31B Opt 01 | C-30B Opt 01 | C-4; C-7 Opt 02; C-7 Opt 03 C-5C Opt 02 C-5C Opt 04 | 122-0894-01 | 016-0359-01 | No adaptor*5 | 016-0269-03 |
| 1 cm Nonilluminated Graticule; 2213(A), 2215(A), 2220, 2230, 2235, 2236 | | | C-7 Opt 02 C-5C Opt 04 | | 016-0359-01 | No adaptor*5 | 016-0269-03 |
| ¼ inch Graticule i.e.;*4*12 305, 314, 326, 335, 336, 1501, 1502 | | C-30B Opt 01*10 | C-4 Opt 03*4 | | No adaptor | No adaptor*5 | 016-0327-01 |
| TM 500 i.e.; SC 502, SC 503, SC 504*4 | | C-30B Opt 01*10 | | | No adaptor | No adaptor*5 | 016-0327-01 |
| Nonilluminated Graticule;*8 2335, 2336, 2336YA, 2337 | | | C-7 Opt 02*8 C-5C Opt 04*8 | | 016-0359-01 | No adaptor*5 | No adaptor |
| **Display Monitors** | | | | | | | |
| 8 cm x 10 cm*2*3 i.e.; 601, 602, 605, 606, 606B, 607 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| Large Screen 10 x 12 cm i.e.;*1 603, 604, 608, 620, 624, 634 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | Not recommended |
| **Older 5 Inch Round*2** | | | | | | | |
| 502, 503, 504, 515, 516, 519, 530 & 540/550/580 Series, 575 | C-51*2*10 | C-53*2*10 | C-59A*10 | | No adaptor | 016-0225-04 | 016-0243-00 |
| **Older 5 Inch Rectangular*2** | | | | | | | |
| 560 Series i.e.;*2 561, 564, 567, 568 | | C-53*2*10 | C-59A*10 | | No adaptor | 016-0224-01 | 016-0244-00 |
| **Television Products** | | | | | | | |
| 380, 381 | | C-30B Opt 01*10 | C-4 Opt 03 | 122-0896-01 | No adaptor | No adaptor | 016-0327-01 |
| 520, 520A, 521, 521A, 522A*1 | | C-59A*10 | | | No adaptor | 016-0295-01 | No adaptor |
| 1480C | | C-53*10 | C-59A*9*10 | | No adaptor | 016-0342-00*9 | No adaptor |
| 528A*2, 1420, 1421, 1422, 1424*1*2 | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| 1710B, 1711B, 1740, 1741, 1742, 1750 | | C-30B Opt 01 | C-4; C-7 Opt 02; C-7 Opt 03 C-5C Opt 02; C-5C Opt 04 | 122-0894-01 | 016-0359-01 | No adaptor*5 | 016-0269-03 |
| **Spectrum Analyzers** | | | | | | | |
| 491*5 | | C-30B | | | No adaptor | No adaptor*5 | 016-0306-01 |
| 492, 492P, 494, 494P, 496, 496P | | C-59A | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | 016-0249-06 | 016-0248-01 |
| **Others** | | | | | | | |
| 576, 5030, 5031 | | Only C-59(A)*10 | | | No adaptor | 016-0288-01 [C-59(A) only] | No adaptor |
| OF150, OF151, OF152, OF235 TDR | | | C-4 Opt 02 C-5C; C-7, C-7 Opt 01 | 122-0895-01 | 016-0357-01 | Not recommended | Not recommended |
| 1240*6*8 | | | C-4 Opt 11 | 122-0898-01 | Not recommended | Not recommended | Not recommended |
| T900 Series, excluding T922R, (see 7000 Series)*8 | | | C-5C Opt 03 C-7 Opt 04 | | 016-0358-01 | No adaptor*5 | No adaptor |
| 308 | | | C-4 Opt 03 | 122-0896-01 | | | |

*1 *Only cameras with <0.7 magnification can record the entire screen area of a 10 x 12 cm display.*

*2 *These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.*

*3 *These scopes do not have illuminated graticules w/o mod.*

*4 *Though these scopes do not have illuminated graticules the graticule may be photographed using storage flood guns on storage models.*

*5 *Due to physical configuration the C-50 Family cannot be mounted.*

*6 *Must use f/22 or f/32 to get enough depth of field for good focus.*

*7 *A corrector lens is required to increase cameras field of view so that the full 8 cm x 10 cm CRT display area can be recorded. The camera should be changed from standard to Option 01. To do this order 016-0301-01 for the standard C-30B or 016-0269-04 for the standard C-31B. These kits include the mounting adaptor and corrector lens.*

*8 *These scopes have no CRT bezel, therefore a camera cannot be mounted. A hand held C-5C, C-7, or C-4 can obtain a record.*

*9 *The C-59A may be used with 016-0224-01, however the image size is reduced.*

*10 *Adaptor not included with camera. Order adaptor separately.*

*11 *Use on scopes with graticule illumination or bistable storage.*

*12 *Scopes do not have graticule illumination.*

*13 *C-30 Series may cut off the first and last small graticule "tick" marks on some scopes.*





**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

## CAMERA COMPARISON GUIDE

| Camera | C-51 | C-53 | C-59A | C-30B | C-31B | C-5C | C-4 | C-7 |
|---|---|---|---|---|---|---|---|---|
| **Features** | Fastest writing speed<br>Adjustable film & shutter speed<br>Built-in view port<br>Remote shutter actuation<br>Interchangeable film backs<br>Single sweep mode | General purpose for instruments with 8 cm x 10 cm CRTs<br>Adjustable film & shutter speed<br>Built-in view port<br>Remote shutter actuation<br>Interchangeable film backs<br>Single sweep mode | General purpose for CRTs up to 6½ inches; low cost<br>Adjustable film & shutter speed<br>Built-in view port<br>Internal batteries<br>Interchangeable film backs | Continuously variable magnification<br>Dual swing-away hinge for viewing the CRT<br>Easy operation<br>Interchangeable film backs<br>Compact size | Max writing speed for portable scopes<br>Dual swing-away hinge for viewing the CRT<br>Easy operation<br>Interchangeable film backs<br>Compact size | Low cost, mounts on most scopes<br>Graticule illuminator<br>Viewing door<br>Easy to use<br>Fixed focus<br>OEM pricing available | Lowest priced Tek camera, hand held<br>Easily interchangeable hoods<br>Scope and video hoods<br>Easy to use<br>Fixed focus<br>OEM pricing available | Motorized film back<br>Auto developing prints. Uses Polaroid AutoFilms<br>Audible indicators<br>Remote shutter activation<br>Fixed focus<br>OEM pricing available |
| **Lens Apertures** | f/1.2 to f/11 | f/1.9 to f/16 | f/2.8 to f/16 | f/1.9 to f/16 | f/1.3 to f/16 | f/16 fixed | f/4.5 to f/32 | f/16 fixed |
| **Magnification** | 0.5 | 0.85 | 0.67 | Variable: 0.7 to 1.5 (0.8 w/Opt 01) | 0.5 (0.43 w/Opt 01) | 0.67 or 0.85 | 0.80, 0.70, 0.85 depending on hood used | 0.67 or 0.85 |
| **Relative light gathering** | 3.0 | 1.0 | 0.65 | 1.0 (0.9 w/Opt 01) | 2.7 (2.9 w/Opt 01) | 0.02 | 0.14 (0.85 mag)<br>0.18 (0.70 mag) | 0.02 |
| **Field of view with Polaroid pack (cm)** | 8 x 10 (Opt 01) | | 10.2 x 12.7 | 8 x 10<br>7 x 9 std | | 9.8 x 12.2 or 8 x 10 | 9.1 x 11.87 (std)<br>10.4 x 13.5 (Opt 02)<br>8 x 10 (Opt 03) | 8.1 x 10.7 or 10.3 x 13.8 |
| **Resolving Power: at center: lines/mm** | 30 or better | | 10 or better | at 1:1<br>25 or better | 30 or better | 6 or better | | |
| **at corners: lines/mm** | 15 or better | | 4 or better | 10 or better | 15 or better | 3 or better | | |
| **Shutter Type** | Electrical, 1/60 to 4 s (bulb, time, single sweep), remote shutter actuation, x-sync, scope "+ gate" input | | Mechanical, 1/125 to 1 s (bulb and time) x-sync | | | Electrical, 1/10 to 5 s, (Time Mode) | Mechanical, 1/125 s to 1 s (bulb), x-sync | Electronic Actuated 1/10 to 5 s, (Time Mode) |
| **Film backs** | Polaroid pack standard with "P" models, Graflok back standard with "G" models | | | Polaroid pack standard with "P" models, Graflok back available (016-0487-00) | | Polaroid pack Noninterchangeable | | Polaroid AutoFilmT Noninterchangeable (CB-33) |
| **Options** | | | Adaptor frame & corrector lens kit for 576 & 5030, reduces magnification to 0.5, order 016-0288-01. | 01 Provides the correct adaptor (016-0269-03) for Tek portables with 8 cm x 10 cm displays. Also includes a corrector lens for optical correction. | | See page 416 for specific selections of options. | 01 (0.85 mag)<br>02 (0.80 mag)<br>03 (0.70 mag)<br>11 (8.3 in diagonal)<br>12 (12.5 in diagonal)<br>See page 409 for specific selections | See Page 411 for specific selections. |
| **Optional Accessories** | Mounting adaptors, battery pack (for C-51, C-53), writing speed enhancer (one for each model), Polaroid pack film back, Graflok 4 in x 5 in back and film holders, x-sync connector, carrying case, foot switch (for C-51 and C-53). | | | Mounting adaptors, writing speed enhancer, Polaroid pack film back, Graflok 4 in x 5 in back and film holders, and carrying case x-sync cable, portra lens (for C-30B only) | | Mounting hood adaptors, flash unit, viewing door | Scope and video adaptor hoods, color filter kit (122-0909-00) | Film, foot switch Mounting hood adaptors, flash unit, battery pack, 110 ac or 220 ac power supplies |
| **Page** | 413 | 413 | 415 | 412 | 412 | 416 | 408 | 410 |
| **Price Begin At** | $2,360 | $1,940 | $1,335 | $1,480 | $1,700 | $495 | $370 | $595 |

### CAMERA MOUNTING ADAPTOR AND HOOD PART NUMBER AND PRICES

| | | | |
|---|---|---|---|
| 016-0217-00 | **$105** | 016-0295-01 | **$85** |
| 016-0223-01 | **$85** | 016-0299-00 | **$95** |
| 016-0224-01 | **$75** | 016-0301-01*3 | **$100** |
| 016-0225-04 | **$75** | 016-0306-01*4 | **$90** |
| 016-0226-01 | **$78** | 016-0327-01 | **$170** |
| 016-0228-01 | **$120** | 016-0342-00 | **$230** |
| 016-0243-00 | **$90** | 016-0357-01*5 | **$20** |
| 016-0244-00 | **$105** | 016-0358-01*6 | **$20** |
| 016-0248-01 | **$85** | 016-0359-01*7 | **$20** |
| 016-0249-06*1 | **$90** | 122-0894-01*8 | **$45** |
| 016-0263-00 | **$90** | 122-0896-01*9 | **$55** |
| 016-0269-03 | **$100** | 122-0896-01*10 | **$55** |
| 016-0269-04*2 | **$100** | | |

*1 *Included with C-50 Series Cameras.*
*2 *Adaptor & lens included with C-31 B Option 01 Cameras.*
*3 *Adaptor & lens kit included with C-30B Option 01 Cameras.*
*4 *Included with Standard C-30B, C-31B Cameras.*
*5 *Included with C-5C and C-5C Option 01 Cameras.*
*6 *Included with C-5C Option 03 Cameras.*
*7 *Included with C-5C Option 02 and Option 04 Cameras.*
*8 *Included with C-4 (Standard).*
*9 *Included with C-4 Opt 02.*
*10 *Included with C-4 Opt 03.*

### POLAROID REPLACEMENT ROLLER ASSEMBLIES FOR PACK FILM BACKS

If your roller assembly is solid gray or two-tone gray. Order 401-0304-00 **$26**

If your roller assembly is red and black. Order 401-0303-00 **$26**

*Note: Because of mechanical differences, both roller assemblies are incompatible with each other's back.*

### ACCESSORIES FOR OLDER TEKTRONIX CAMERAS

**Polaroid Pack Film Back for Older Cameras: C-12, C-19, C-13, C-27**
These cameras are no longer produced by Tektronix. However due to customer need for a Pack Film Back these are now available. The Pack Film Back accepts the Polaroid pack film. (3¼ inch x 4¼ inch). Order 122-0671-01 **$275**

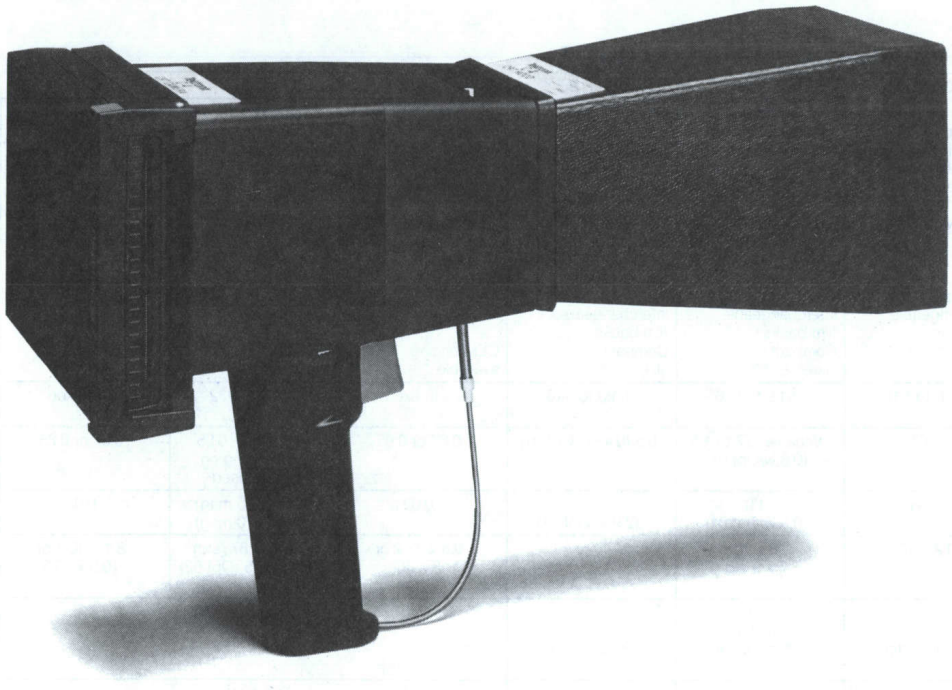
**Mounting Adaptors for C-12**
C-12 to 7000 Series and 5000 Series. Order 016-0299-00 **$95**

C-12 to 530, 540, 550 Series. Order 016-0226-01 **$78**

C-12 to 560 Series rectangular CRTs. Order 016-0217-00 **$105**

**Writing Speed Enhancer for C-12, C-27**
Provides controlled film fogging to increase writing speed by 3X for 3000 ASA film and >3.5X with 20,000 ASA film. Installs in minutes. Order 016-0280-02 **$380**

**Carrying Case for C-12, C-27**
Order 016-0208-01 **$800**



*Standard C-4 Hand-Held Camera*

# C-4

**Hand-Held Operation**

**No Focusing Required**

**Four Element f/4.5 Glass Lens System**

**Mechanical Shutter**

**Adapts to Most Tektronix and Non-Tektronix Scopes and CRT Displays**

**Five Easily Interchangeable Scope Hoods**

**Two Large Hoods for Video Screens**

**OEM Pricing Available**

A camera can be a key part of your measurement system. It allows you to capture events, document the results, and it helps to *communicate* the results with clarity and credibility.

The C-4 is a high quality CRT documentation camera at an affordable price. The C-4 is an easy-to-use hand-held camera system that uses Polaroid instant pack films which develop in seconds, giving you immediate results. The C-4 is ideal for the lab, classroom, medical facility, TV studio, or design bench. Two video hoods allow instant prints to be made from many common video CRTs.

### A Snap to Use

Anyone can take sharp, quality instant pictures after just a few minutes of familiarization with the camera and manual. No photographic skill or training is required!

### Portable

The C-4 is hand-held, thus easily moved between test locations without having to remove mounting hardware.

For easy handling, the contoured pistol grip includes a trigger button for the shutter release.

### Tektronix and Non-Tektronix Product Compatibility

The five easily interchangeable hoods allow the C-4 camera to fit most Tektronix and non-Tektronix oscilloscopes and CRT displays.

The C-4 is recommended for scopes with either illuminated graticules or bistable storage displays. On nonilluminated graticule scopes the C-4 will only record the waveform.*1

For Tektronix products compatibility see page 406.

For other Tektronix products not listed on page 406, and non-Tektronix oscilloscopes and CRT-based products, refer to mechanical and field of view compatibility below.

**1 The Tektronix C-5C Camera, with flash, is recommended for scopes that do not have an illuminated graticule.*

### Hood Selection

The hood is a key part of the C-4 system since it places the camera at the correct distance from the CRT screen, blocks out ambient light, and has a built-in corrector lens to properly focus the image and sets the magnification ratio. Each hood has two snap locks to insure quick interchangeability.

### Mechanical Compatibility

It is suggested that the hood's front lip dimensions be used as a guide when determining physical compatibility (see Adaptor Hood Selection Guide on next page). Note: Hoods can fit around the CRT bezel or they can fit against the CRT's face, inside the bezel.

### Field of View Compatibility

Check to see that the hood selected provides a large enough field of view (how large a CRT display the camera will fully record). Refer to Scope Hood Selection Guide on the next page.

### C-4 VIDEO PRODUCT COMPATIBILITY GUIDE

Ths following lists compatibility currently tested. Please refer to page 409 for determining compatibility on products not listed.

| DISPLAY | C-4 VIDEO HOOD | |
|---|---|---|
| | Opt 11 | Opt 12 |
| Tektronix: 4104(A), 4105(A), 4106(A), 4107(A) | | ✓ |
| Ann Arbor Ambassador *1*4 | | ✓ |
| Apple II Monitor G0905 | ✓ | |
| Apple MacIntosh Display | ✓ | |
| Compac "Plus"*2 | ✓ | |
| DEC VR-241*1 | | ✓ |
| DEC MATE II VR-201A*2*3*4 | | ✓ |
| Heathkit H-19*2 | | ✓ |
| IBM PC Jr. Monitor 4863*1 | | ✓ |
| IBM Color PC Monitor 5153 | | ✓ |
| IBM PC Portable | ✓ | |
| NEC JB-1201M Monitor | | ✓ |
| Panasonic TR-930 Monitor | ✓ | |
| Quad Chrome Color Monitor | | ✓ |
| Sony KV1217 Color Monitor | | ✓ |
| Tandy Color Monitor 16-230 | ✓ | |
| Zenith ZVM-122*2 | ✓ | |
| Zenith ZVM-121*2*4 | | ✓ |
| Zenith ZVM-135 | | ✓ |

**1 Cuts off some of the CRT.*
**2 Tends to have soft focus.*
**3 Possible light leaks since CRT has less curvature than the hood.*
**4 Optical distortion more noticeable.*
*Note: Will not work on:*
- *Tek: 4025, 4027, or 4050 Series.*
- *Tandy Computers with built-in CRTs.*
- *Apple IIc Monitor A2M2010.*

**For additional hoods see next page.**

**Special pricing terms and conditions are available to qualified OEMS. Contact your local Tektronix representative for complete information.**

*C-4 Camera Body with Hoods; (Left to Right) Option 12, Option 11, Option 02, standard and Option 03.*

## CHARACTERISTICS

**Aperture** — f/32 to f/4.5 (continuously variable).

**Lens** — Four glass elements.

**Focal Length** — 105 mm nominal (without hood).

**Magnification** — Dependent on hood. See Adaptor Hood Selection Guide at right.

**Resolving Power** — At Center: At least 6 lines/mm. At Camera: At least 3 lines/mm.

**Relative Light Gathering Ability** — See Adaptor Hood Selection Guide on this page.

**Field of View** — Dependent on hood. See Adaptor Hood Selection Guide on this page.

**Shutter** — Mechanical; 1/125 s, to 1 s, and bulb.

**Synchronization** — X-sync switch closure occurs when the shutter reaches its fully open position.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 180 | 7.4 |
| Height (w/pistol grip | 236 | 9.3 |
| Height (w/out pistol grip | 119 | 4.7 |
| Depth (w/std hood) | 363 | 14.3 |
| Depth (w/out std hood) | 185 | 7.3 |
| **Weights≈** | **kg** | **lb** |
| Net w/std hood | 1.0 | 2.1 |
| Net w/out std hood | 0.8 | 1.8 |

## ORDERING INFORMATION

**(One hood included, additional hoods must be purchased separately. See chart at right.)**

**C-4 Camera** **$370**

**Includes:** Body; Pistol Grip (122-0901-00); hood (122-0894-01); operator manual (070-5000-01).

### OPTIONS

**Option 01** — Delete Hood (Body only). **−$45**

**Option 02** — Substitute 122-0895-01 Hood. **NC**

**Option 03** — Substitute 122-0896-01 Hood. **NC**

**Option 11** — Substitute 122-0898-01 Hood. **+34**

**Option 12** — Substitute 122-0899-01 Hood. **+53**

## ADDITIONAL C-4 ADAPTOR HOODS

**Extend the C-4's flexibility with additional snap-on Hoods**

**Scope Hoods**

| Scope Hood Part Number | Dimensions*1 Nominal Front Lip Height*3 mm | Height*3 in | Width*3 mm | Width*3 in | Hood Length*2*5 mm | Length*2*5 in | Relative Light Gathering | Field of View*1 (cm) | Magnification | Hood Net Weight kg | Weight lb | Hood Price only |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122-0894-01 (w/Std C-4) | 108 | 4.2 | 122 | 4.8 | 178 | 7.2 | 0.15 | 9.1 x 11.87 | 0.8 | 0.1 | 0.3 | $45 |
| 122-0895-01 (w/ Opt 02) | 132 | 5.2 | 143 | 5.6 | 206 | 8.1 | 0.18 | 10.4 x 13.5 | 0.7 | 0.2 | 0.4 | $55 |
| 122-0896-01 (w/Opt 03) | 80 | 3.2 | 100 | 3.9 | 171 | 6.8 | 0.14 | 8.0 x 10.0*2 | 0.85 | 0.1 | 0.3 | $55 |

**Video Hoods**

| Video Hood Part Number | Dimensions*1 Nominal Front Lip Height mm | Height in | Width mm | Width in | Diagonal Inside mm | Inside in | Outside mm | Outside in | Hood Length*5 mm | Length*5 in | Magnification | Hood Net Weight kg | Weight lb | Hood Price only |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122-0898-01 (w/Opt 11) | 127*3 | 5.0*3 | 168*3 | 6.6*3 | 211 | 8.3 | 213 | 8.4 | 257 | 10.1 | 0.55 | 0.3 | 0.7 | $79 |
| 122-0899-01 (w/Opt 12) | 186*4 | 7.3*4 | 262*4 | 10.3*4 | 318 | 12.5 | 323 | 12.7 | 404 | 15.9 | 0.35 | 0.6 | 1.4 | $98 |

**1 Nominal dimensions.*

**2 Image size is limited by front opening of the hood.*

**3 For outside dimensions add 0.30 cm (0.12 in) to each value. Each wall thickness nominally is 0.15 cm (0.06 in).*

**4 For outside dimensions add 0.14 in to each value. Each wall thickness nominally is 0.07 in.*

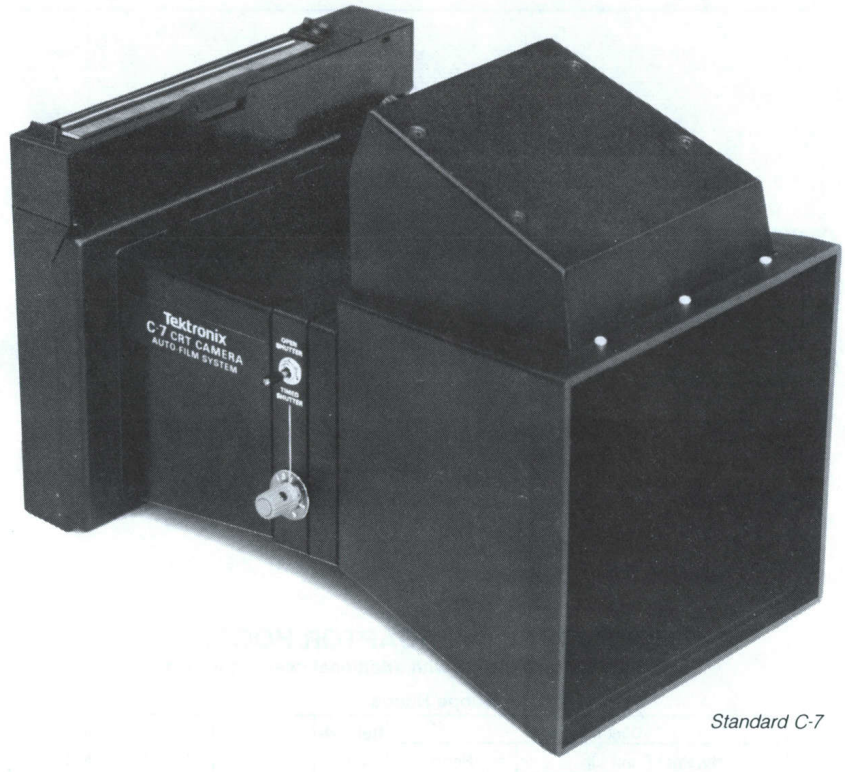
**5 From mounting surface to front lip.*

### OPTIONAL ACCESSORIES

**Split-Image Focus Plate** — Fits into the pack film back (with no film loaded, useful to determine if image is properly in focus and entirely within the camera's field-of-view. Order 387-0893-02 **$4.00**

**Color Filter Kit** — Consists of 40.5 mm screw-in 85B filter, corrects the color film balance for most color CRTs. Order 122-0909-00 **$13.50**

**For recommended films, see page 405.**




*Standard C-7*

# C-7

**Motorized Back**

**Automatic Print Ejection and Development**

**Uses New Integral AutoFilm™ from Polaroid**

**No Focusing Required**

**Reliable, Electronically Activated Remote or Manual Shutter**

**Audible Indicators**

**Protective Circuitry**

**Battery or AC Power Supply Operation**

**Snap-on Print Holder**

**Graticule Flash on Some Versions**

**OEM Pricing Available**

**The Tek C-7 Auto-eject Camera delivers hands-off hard copies in seconds.**
This new general purpose CRT camera incorporates Polaroid's new AutoFilm™ system that includes a motorized camera back, three new integral films and a snap-on holding chamber.

The camera automatically ejects the film after each exposure. Once ejected, the film develops in about 60 seconds to a clean, dry, print or transparency. No trimming, peeling or coating is necessary. Prints or transparencies can be collected in the snap-on holder (which is required for the first 30 seconds of transparency film development).

The C-7 was designed so that the user will not have to handle prints until they are completely developed. This is especially important in medical or clean room applications where film handling may cause chemical contamination. Another benefit is that the rollers will not have to be cleaned as often since the chemicals are contained inside the print.

**The Lens/Shutter System is a snap to use.**
Shutter speed is the only control which requires adjustment on the C-7. The fixed-focus glass f/16 lens system delivers sharp prints. The reliable electronic shutter assures accurate exposures. Some versions of the camera have a flash in the hood to illuminate displays that do not have graticule illumination.

The camera is externally powered by a detachable battery pack (held by two velcro strips), an AC power supply, or your own power source.

**An advanced feature set brings a new standard of convenience to photographic recording.**
The C-7 has audible indicators that beep after last exposure, and after each exposure when the input voltage is low.

The camera can be operated by the manual shutter or by an optional foot switch via the remote shutter input jack.

Protective features include: voltage regulation, overcurrent foldback protection and under voltage warning (buzzer).

Magnification can be changed by reversing the lens/shutter module and the spacer modules positions.

Mounting and dismounting is easily accomplished on instruments with Tek-style bezels.

You'll find the built-in CRT viewing door handy when setting up for a picture.

There is even a built-in exposure counter in the camera back!

**Polaroid AutoFilm™**
The Tektronix C-7 Camera System uses Polaroid's AutoFilm™ exclusively. These integral films were especially developed to work in Polaroid's motorized AutoFilm™ back which the C-7 uses:

(Note: the AutoFilm™ film packs do not contain internal batteries as Polaroid consumer films).

**Type 331** (ASA 400) is a black-and-white extended gray-scale film for video image recording, providing prints that reproduce the full range of black-and-white densities displayed on video monitors and scope CRTs.

Type 331 film is available from Tektronix—see "optional accessories" section.

*Presently there is not a high-speed film available, therefore the C-7's applications may be slightly limited. (Faster film(s) may be available from Polaroid in 1986.)*

**Type 336** (ASA 100) is a black-and-white high resolution negative transparency film. (It is scheduled for availability in 1986.)

**Type 339** (ASA 640) is a high-speed color print film for reproducing color CRT displays. (The color film provides a print with a reversed or mirror image unless the CRT screen image is electronically reversed before making the exposure. This is a function of the film design, not the C-7.)

The AutoFilm™'s usable image area is 4 in x 3 in, though the actual image size will depend on the magnification and the size of the display.

The 10 exposure film packs mean fewer film changes for you. When the C-7 ejects the last print, the camera will automatically produce an audible tone for about 1 second.

**Product Compatibility**
The C-7 camera can be mounted on most models of Tektronix oscilloscopes and small monitors, using the same hoods as the C-5C. See page 406 for compatiblity chart.

Non-Tek displays can be photographed if the product uses a Tek style bezel, or if the camera is held up to the CRT.

Your local Tek representative has selected listings of non-Tek products that are compatible with the C-7. The best test is to actually try one on your display.

**Technical assistance with AutoFilm is available from Polaroid. In U.S. call 1-800-225-1618. Outside U.S. contact local Polaroid dealer.**

*Shown above: C-7 and options. Rear left to right: Standard C-7, with Option 01, with Option 02, with Option 03, with Option 04, with Option 05, with Option 20, OEM camera with view ports. Front left to right: Print holding chamber, foot switch, battery pack, service manual, 220 V ac power supply, 110 V ac power supply.*

## CHARACTERISTICS

### Optional/Mechanical

**Relative Aperture** — Fixed at f/16.

**Magnification Factor** — 0.67 or 0.85.

**Lens** — Three glass elements.

**Relative Light-Gathering Ability** — 0.02

**Field of View (Nominal)** — 8.1 cm x 10.7 cm (13.4 cm diagonal) at 0.85 mag; or 10.3 cm x 13.8 cm (17.3 cm diagonal) at 0.67 mag.

**Shutter** — Electronic Actuated: 1/10 to 5 s, open shutter mode.

**Remote Shutter Jack** — Open collector TTL compatible (for use with foot switch).

**Time Between Shots** — ≈4 s (plus shutter time).

**Audible Indicators (Buzzer)** — Out-of-Film Warning: After tenth print is ejected, buzzer will sound for approximately one second. Low or High Voltage Warning: Buzzer will sound during the film-eject cycle when the batteries start to get weak.

**Status Outputs** — Various status outputs (switch closures and openings) such as "end of film," "dark slide," etc., are available only as a modified product.

### POWER REQUIREMENTS

The C-7 requires external power from an ac power supply, battery pack, or a customer supplied source via a Lemo connector.

**Voltage** — 8 V to 12 V. (Can be configured for 5 V to 12 V, see service manual.)

**Current** — Idle: ≈1 mA. Maximum: 3 A for 10 s.

**Mechanical Interface** — Lemo type connector (cable end connector, Tektronix part number 131-0778-00).

### POWER SUPPLIES (OPTIONAL)

**110 V (119-1847-02)** — Output Voltage: 9.5 V nominal. Output Current: 1.5 A nominal, 3 A peak. Line Voltage: 90 V ac to 132 V ac, 50 Hz to 60 Hz nominal.

**220 V (119-1847-03)** — Output Voltage: 9.5 V nominal. Output Current: 1.5 A nominal, 3 A peak. Line Voltage: 180 V ac to 250 V ac, 50 Hz to 60 Hz nominal.

**Battery Pack (016-0799-01)** — Number of Cells: Eight. Type of Cells: Alkaline or NiCad AA. (Batteries not included, velcro strips included.)

### PHYSICAL CHARACTERISTICS

| Std C-7 w/Flash Dimensions ≈ | mm | in |
|---|---|---|
| Width | 180 | 7.1 |
| Height to top of flash | 196 | 7.7 |
| Height with Chamber | 264 | 10.4 |
| Depth | 251 | 9.9 |
| **Weights ≈** | **kg** | **lb** |
| Net | 1.3 | 3.7 |
| Shipping | 2.6 | 5.8 |

**Hoods** — Uses C-5C adaptor hoods. Refer to hood's dimensions on page 416.

## ORDERING INFORMATION

C-7 requires a power source (does not come as a standard accessory). Order Opt 30, Opt 31, or Opt 32 or use your own power via Lemo connector.*2

**C-7** Camera with Flash **$595**

**Includes:** Adaptor hood (016-0357-01); print holding chamber (122-1039-00); circuit board covers for 0.67 mag (200-3074-00); for 0.87 mag (200-3031-00); operator manual (070-5127-00).

### OPTIONS

**Option 01** — 016-0357-01 Hood and no Flash. **−$30**

**Option 02** — 016-0359-01 Hood and Flash. **NC**

**Option 03** — 016-0359-01 Hood and no Flash. **−$30**

**Option 04** — 016-0358-01 Hood and Flash. **NC**

**Option 05** — 016-0358-01 Hood and no Flash. **−$30**

**Option 20** — Camera Body Only, no Flash or Hood. **−$20**

**Option 30*2** — With 016-0799-01 Battery Pack (batteries not included). **+$20**

**Option 31*2** — With ac Power Supply (110 V). **+$50**

**Option 32*1*2** — With ac Power Supply (220 V). **+$55**

**1 Requires a power cord (not included) which will have the correct plug for the particular country. See right.*

**2 One of each power source can be ordered.*

### INTERNATIONAL POWER PLUG OPTIONS
**(Required for 220 V Ac Power Supply)**

Universal Euro 220 V/16 A, 50 Hz.
Order 161-0066-09 **$6.50**
UK 240 V/13 A, 50 Hz. Order 161-0066-10 **$11**
Australian 240 V/10 A, 50 Hz.
Order 161-0066-11 **$8.25**
Switzerland 220 V/10 A, 50 Hz.
Order 161-0154-00 **$12**

### OPTIONAL ACCESSORIES

**Type 331 Film**
Bundle, 3 twin packs (60 prints).*1
Case, 10 twin packs (200 prints).*1

**Extra Print Holding Chamber** —
Order 122-1039-00 **$5.00**

**Foot Switch with 8 ft Cable** —
Order 260-1189-02 **$22.50**

**Extra Battery Pack with Lemo Connector** —
Batteries not included. Order 016-0799-01 **$20**

**Lemo Connector for Power-In** —
Order 131-0778-00 **$14**

**Ac Power Supplies** — 8 ft cable with Lemo Connector.
110 V ac Version. Order 119-1847-02 **$50**
220 V ac Version. Order 119-1847-03*2 **$55**

**Service Manual** — C-7 Camera Order 070-5051-00*1

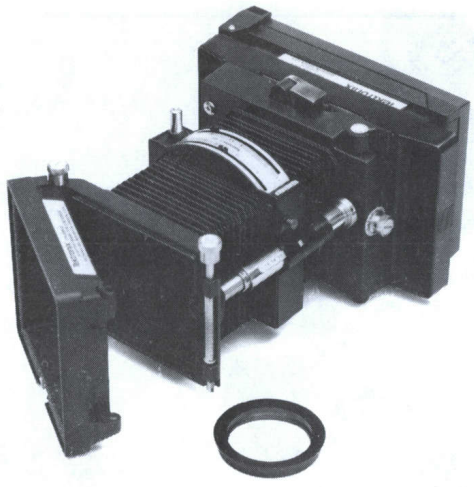
**1 Contact your local sales office.*

**2 Requires power cord from list at top of column.*

**FOR ADDITIONAL HOODS, GRATICULE FLASH UNIT, OR LARGE VIEWING DOOR SEE C-5C OPTIONAL ACCESSORIES SECTION ON PAGE 416.**

**OEM terms available on this product.**

C-31BP



## C-30 Series

**Adaptable to Many Instruments**

**Standard Models Cover 0.8 cm/div CRTs**

**Optimized for 8 cm x 10 cm CRTs (Option 01)**

**Continuously Variable Magnification (C-30B)**

**Writing Speed Enhancer Available**

**Reduced Image Size with C-31B (0.5 Mag)**

**Interchangeable Backs**

**Swings Away for CRT Viewing**

The standard versions of the C-30B and C-31B are primarily for use on the older 400 Series portables that have 0.8 cm/div CRTs. (Mounting adaptor, 016-0306-01, is included.)

The Option 01 models are the same cameras except that a slip-on corrector lens is used for coverage of 8 cm x 10 cm displays, and a different mounting adaptor (016-0269-03 for 2400 Series, 465, etc.) is included.

The C-30B/C-31B cameras can be used on some 7000 and 5000 Series lab scopes (with 8 cm x 10 cm displays); 300 Series; Sony/Tek portables; as well as some 600 Series monitors. See Camera Selection Guide on page 406 for compatibility information.

Dual swing-away hinges allow the camera to be swung out of the way, either to the left or right, for direct viewing of the CRT. The cameras are focused, using a split-image focus plate placed inside the Polaroid back. Graflok back cameras use the back's (Graflok) built-in viewing glass.

## C-30B

The C-30B is a versatile, general purpose camera for scopes that have 0.8 cm/div CRTs. The C-30B offers a highly reliable mechanical shutter and an f/1.9 lens. It is the only Tektronix oscilloscope camera that features continuously variable magnification (from 0.7 to 1.5) giving you greater photographing flexibility. This version is recommended for the 453, 454, 485 and 491.

## C-30B Option 01

The C-30B Option 01 offers an expanded field of view. The f/1.9, 0.8 magnification lens covers an 8 cm x 10 cm CRT screen without vignetting. This camera is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

NOTE: The C-30B w/corrector lens is optimized for use at 0.8 mag only.

### C-30B CHARACTERISTICS

Specifications are the same for the C-30B and C-30B Option 01 unless otherwise noted.

**Aperture** — Variable from f/1.9 to f/16.

**Magnifications** — Variable from 0.7 to 1.5, (0.8 magnification on Option 01 with C-30B set to 1.0 magnification).

**Resolving Power** — (at 1:1 magnification). Center: At least 25 lines/mm. Corners: At least 10 lines/mm.

**Relative Light-Gathering Ability** — 1.0 (0.9 on Option 01).

**Shutter** — Mechanical; 1/125 to 1 s; bulb and time.

**Synchronization Output** — X-sync contact closure.

**Field of View** — Standard: 7.0 cm x 9.0 cm. Option 01: 8.0 cm x 10.0 cm.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 191 | 7.5 |
| Height | 130 | 5.1 |
| Depth | 254 | 10.4 |
| **Weights ≈** | **kg** | **lb** |
| Net | 2.2 | 4.8 |
| Shipping | 4.1 | 9.0 |

## C-31B

This camera's f/1.3, 0.5 magnification lens offers the fastest writing speed for 2400 and 400 Series oscilloscopes. The 0.5 magnification means that the image size on the print will be approximately one half of the C-30Bs. The C-31B is for 0.8 cm/div CRTs (453, 485, 491, 454).

## C-31B Option 01

The C-31B Option 01 offers an expanded field of view. This f/1.2, 0.43 magnification lens system has a relative light-gathering ability of 2.9 covering CRT screens up to 8 cm x 10 cm. It is recommended for the 2400 Series, 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

### C-31B CHARACTERISTICS

Specifications are the same for the C-31B and C-31B Option 01 unless otherwise noted.

**Aperture** — Variable from f/1.3 to f/16.

**Lens Speed** — f/1.3

**Resolving Power** — At Center: At least 30 lines/mm. At Corners: At least 15 lines/mm.

**Magnification** — Fixed at 0.5 (0.43 on Option 01).

**Relative Light-Gathering Ability** — 2.7 (2.9 on Option 01).

**Shutter** — Mechanical; 1/125 to 1 s; bulb and time.

**Synchronization** — X-sync contact closure.

**Field of View** — Standard: 7 cm x 9 cm. Option 01: 8 cm x 10 cm.

#### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 231 | 9.1 |
| Height | 140 | 5.5 |
| Depth | 269 | 10.6 |
| **Weights ≈** | **kg** | **lb** |
| Net | 3.1 | 6.8 |
| Shipping | 5.4 | 11.0 |

### ORDERING INFORMATION

("P" denotes that the camera has a 3 in x 4 in pack film back. All models include Polaroid pack film back)

**C-30BP Camera** **$1,480**

**Includes:** Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); mounting adaptor (016-0306-01); instruction manual (070-2825-00).

**Option 01** — Expanded Field of View. **+$44**

**Includes:** Sames as C-30BP except it comes with 016-0269-03 mounting adaptor instead, plus corrector lens (352-0341-01).

**C-31BP Camera** **$1,700**

**Includes:** Same as C-30BP, except instruction manual 070-2869-00 instead.

**Option 01** — Expanded Field of View. **+$44**

**Includes:** Same as C-31BP except it comes with 016-0269-03 mounting adaptor instead, plus corrector lens (122-0980-00).

#### CONVERTING OPTION 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the corrector lens, removing the mounting adaptor, and adding an 016-0306-01 mounting adaptor. Refer to pages 406-407 for compatibility and price.

#### CONVERTING STANDARD MODEL TO OPTION 01 MODEL

A standard-model C-30A/B or C-31B can be converted to an Option 01 model by means of a conversion kit which contains a mounting adaptor (016-0269-03) plus the appropriate corrector lens (see Option 01's "Included Accessories").

Standard C-30A/B to Option 01.
Order 016-0301-01 **$100**

Standard C-31B to Option 01. Order 016-0269-04 **$100**

See pages 406-407 for prices and compatibility.



To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## C-30 SERIES OPTIONAL ACCESSORIES

**Mounting Adaptors** — See page 406.

**Writing Speed Enhancer** — (For C-30A/B and C-31B) Increases effective film speed about 3X for 3000 speed film. Now supports 20,000 ASA (612) film. Installs in minutes. See page 405. Order 016-0284-02 **$280**

**Polaroid Pack Film Back** — Accepts Polaroid 3 in x 4 in pack film for C-30A and C-30B. Included with "P" models. (Focus plate included.) Order 122-0752-02 **$185**

**Split-Image Focus Plate** — Included with "P" models. Order 387-0893-02 **$4.00**

**Graflok Type 4 in x 5 in Back** — Accepts Polaroid Land 4 in x 5 in film holders, standard cut film holders, filmpack adaptors, roll film holders (except heavy motorized roll film holders). Order 016-0487-00 **$250**
See below for film holders which are required for operation.

**Carrying Case** — Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 in x 14.5 in x 8 in. Order 016-0587-00 **$120**

**X-Sync Cable** — Order 012-0364-01 **$25**

**Portra Lens** — A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a maximum distance of 21 in the camera covers 19 in x 21 in. Usable with either the C-30B or C-30B Option 01(but not with the C-31A or C-31B). Order 016-0246-02 **$35**

### OPTIONAL FILM HOLDERS FOR GRAFLOK TYPE BACKS (C-50 Series "G" Models or C-30 Series with Graflok Back)

Cameras with Graflok type backs must have a film holder in order to be functional.

Here are several holders*[1] that allow the use of roll film, or 4 in x 5 in Polaroid films. Order these holders from Tek, the manufacturer, or from your local camera store.

**Polaroid Land #545 4 in x 5 in Film Holder** — For Polaroid 4 in x 5 in Single Exposure Film Packets. Order 016-0201-01 **$285**

**RH/10 120 Roll-Film Holder** — Ten exposures 2¼ in x 2¾ in for 4 in x 5 in Graflok backs. Order 122-0736-01 **$360**

**RH/50 70 mm Holder** — Fifty exposures, 2¼ in x 2¼ in for 4 in x 5 in Graflok backs only. Order 122-0967-00 **$330**

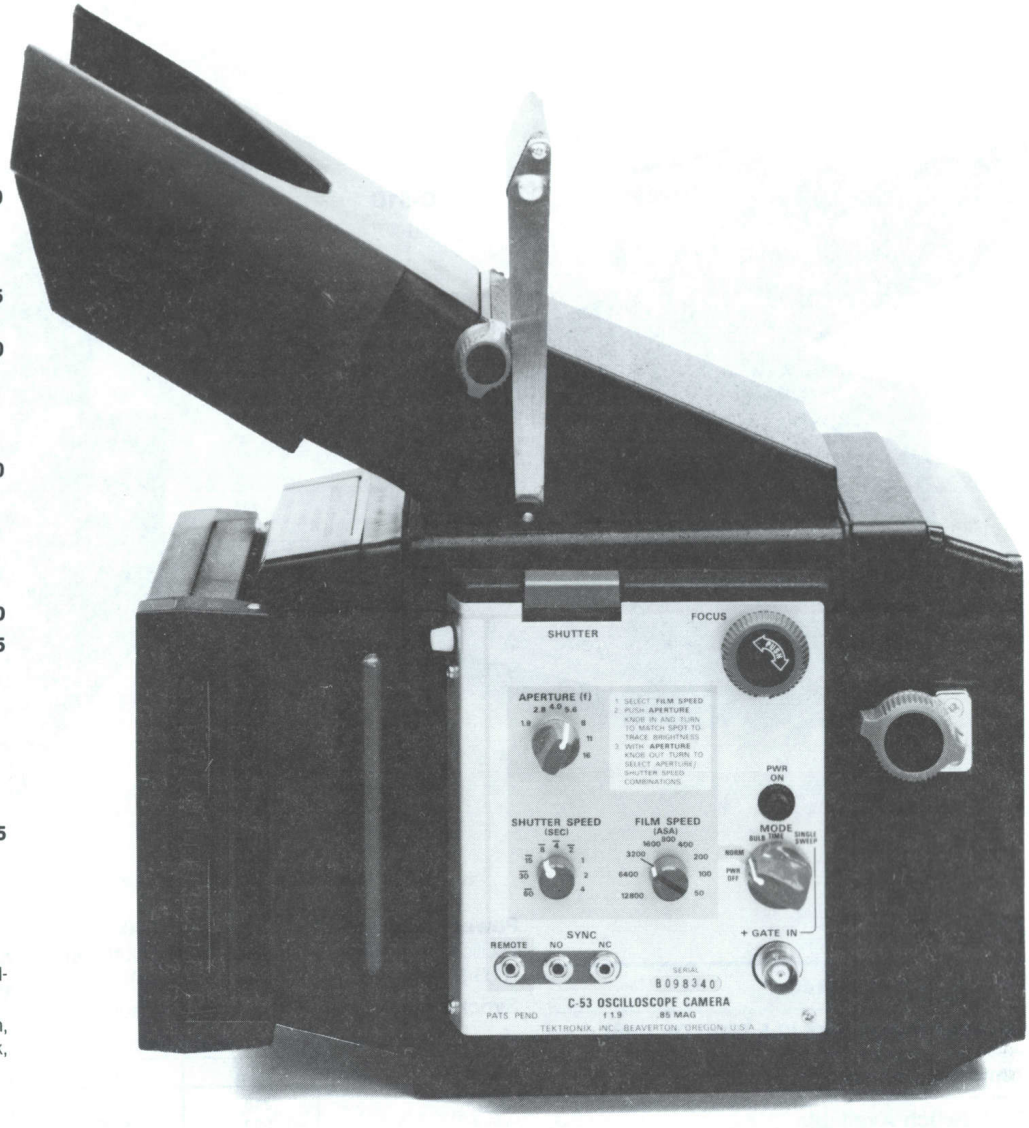
Roll film holders are also manufactured by several other companies.

*[1] *Other film holders and adaptors (4 cm x 5 cm cut film, pack film, or roll film) are available at local camera store.*

The following film holders are available only through Polaroid (1-800-225-1618 in the U.S.).

**Polaroid #550 Film Holder** — For Polaroid 4 in x 5 in pack films. Holder fits most 4 x 5 cameras and instruments equipped with Graflok backs, which accept conventional 4 in x 5 in film holders.

**Polaroid #405 Film Holder** — For Polaroid 3¼ in x 4¼ in pack films. Holder fits most 4 in x 5 in cameras or instruments equipped with Graflok backs, which accept conventional 4 in x 5 in film holders.




## C-50 Series Features

- Electronic-Actuated Shutter (C-51, C-53)
- High Resolution Images
- Photometer Exposure Aid
- Range-Finder Focusing
- Interchangeable Film Backs
- Swings Away from Scope

### The Top of the Line

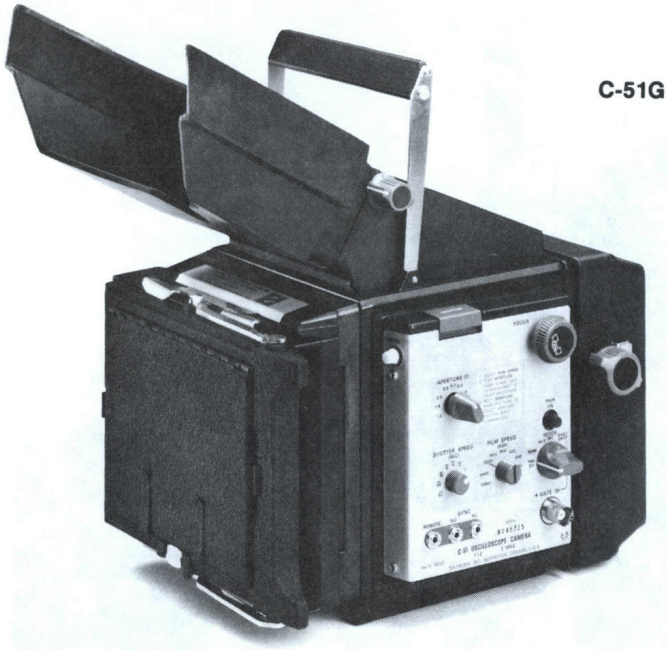
The three C-50 Series cameras are designed for use with all Tektronix 7000 Series oscilloscopes, and can be adapted to fit most 5000 Series oscilloscopes as well as other Tek instruments. Full selection of film backs, and adjustable film and shutter speeds give you the flexibility you need to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces.

X-sync connectors allow the camera shutter to trigger the event. And the camera's built-in viewing tunnel lets you see what's on the display when the camera is in place.

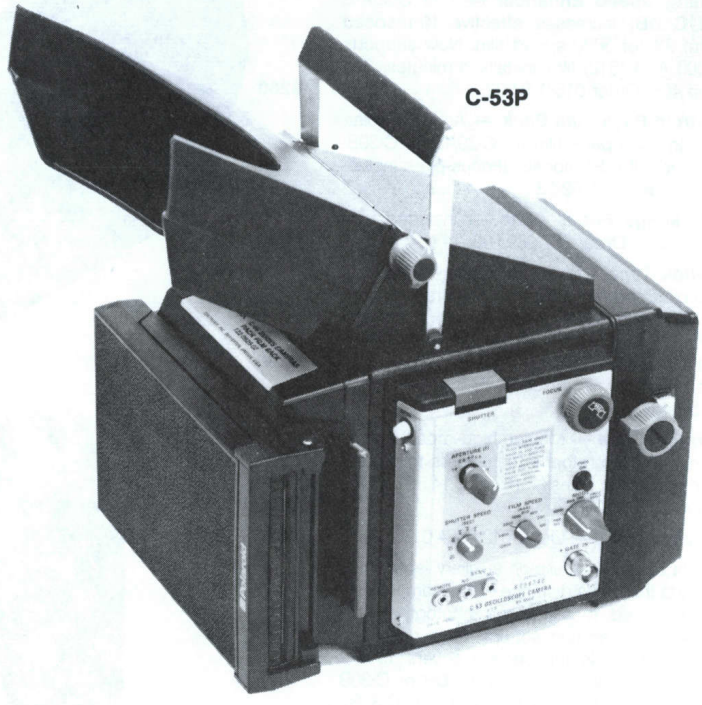
The camera shutter (C-51 and C-53) is electrically actuated, open and close, by shutter button, or remotely through a remote input connector located on the side control panel.

When the C-50 Series camera is used with the Tektronix 7000 Series oscilloscopes, a three-pin connector in the oscilloscope bezel applies power to the camera and receives from the camera a pulse for resetting the oscilloscope sweep when the oscilloscope and camera are both in single-sweep modes. Also, when the oscilloscope and camera (C-51 and C-53 only) are in the single-sweep mode, the "+ gate" output from the oscilloscope can be applied to the "+ gate" input connector on the camera to close the shutter five seconds after the end of the oscilloscope sweep.

**The C-51 and the C-53 are available in ruggedized versions. Contact your Tektronix sales office for further details.**



C-51G



C-53P

## C-51

**Fastest Writing Speed**

**Reduced Image Size (0.5 Mag) On Print**

**Remotely Controllable Shutter**

**Foot Switch Available**

**Writing Speed Enhancer Available**

This camera offers the fastest writing speed of any Tektronix oscilloscope camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to the image size on the film. The C-51's electric shutter can operate at speeds ranging from 1/60 to 4 seconds, and offers bulb, time, and single sweep modes by manual or remote control.

### C-51 CHARACTERISTICS

**Aperture** — Variable from f/1.2 to f/16.

**Magnification** — 0.5.

**Resolving Power** — Center: At least 30 lines/mm. Corners: At least 15 lines/mm.

**Field of View** — 8 cm x 10 cm (with pack film).

**Relative Light-Gathering Ability** — 3.0.

**Shutter** — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

**Power Requirement** — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

**Synchonrization** — X-sync switch closure.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 248 | 9.8 |
| Height | 292 | 11.5 |
| Depth | 273 | 10.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 4.3 | 9.5 |
| Shipping | 6.8 | 15.0 |

## C-53

**Medium Speed**

**General Purpose Camera with 0.85 Mag**

**Remotely Controllable Shutter**

**Foot Switch Available**

**Writing Speed Enhancer Available**

The C-53, with a 0.85 mag lens, provides the largest practical image of an 8 cm x 10 cm CRT display on Polaroid 3¼ x 4¼ pack film. Its f/1.9 lens and 0.85 magnification offer somewhat slower writing speed than the C-51. This camera's electric shutter offers speeds ranging from 1/60 to 4 seconds, and can be operated manually or remotely in bulb, time, or single sweep mode.

### C-53 CHARACTERISTICS

**Aperture** — Variable from f/1.9 to f/16.

**Magnification** — 0.85.

**Resolving Power** — Center: at least 30 lines/mm. Corners: at least 15 lines/mm.

**Field of View** — 8 cm x 10 cm (with pack film).

**Relative Light-Gathering Ability** — 1.0.

**Shutter** — Electric; 1/60 to 4 s, bulb, time, and single sweep modes, manual or remote control. Scope's "+ gate" is used for shutter actuation.

**Power Requirement** — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

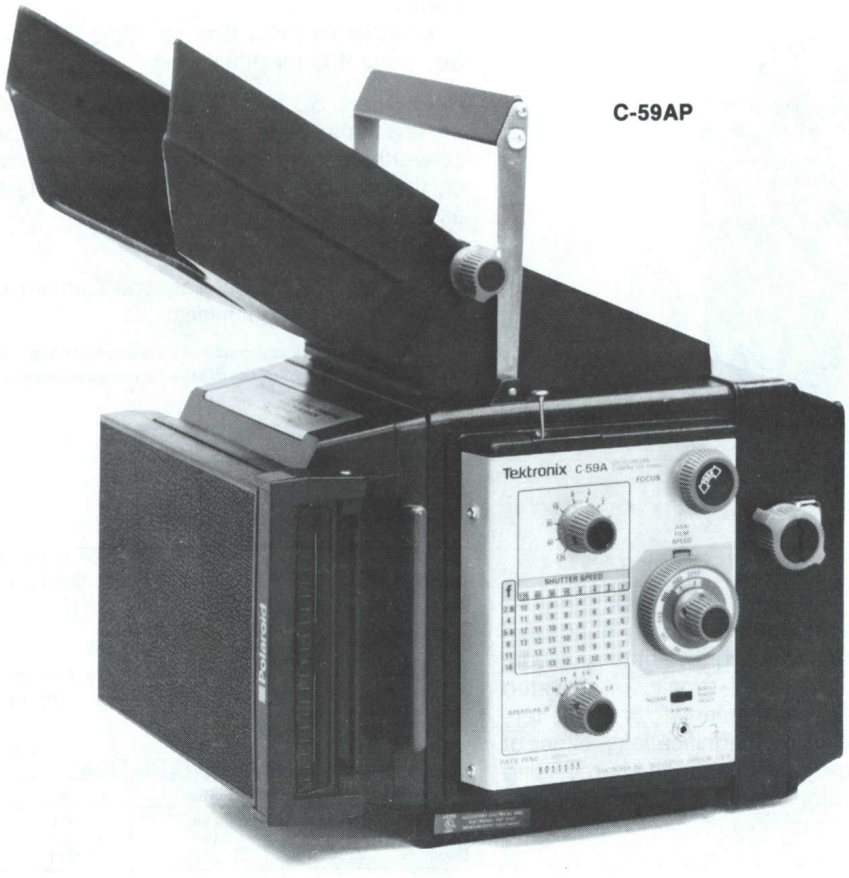
**Synchronization Output Jack** — X-sync switch closure output.

**Field of View** — 8 cm x 10 cm (with pack film).

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 191 | 7.5 |
| Height | 292 | 11.5 |
| Depth | 273 | 10.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 2.4 | 7.5 |
| Shipping | 5.4 | 12.0 |

**For Ordering Information see next page.**




C-59AP

# C-59A

**For Larger CRTs (0.67 Mag)**

**Mechanical Shutter**

**Lowest Priced C-50 Series**

**Writing Speed Enhancer Available**

**Photometer Exposure Aid**

**Range-Finder Focusing**

**Internal Battery or External Power**

This camera is designed for CRTs up to 6½ inches (10.2 cm x 12.7 cm field of view with Polaroid pack film). With the use of an adaptor frame/corrector lens optional accessory, the camera's field of view can be expanded to fully cover the 6½ inch CRT and adjacent scale readout characters of the Tektronix 576 Curve Tracer and the 5030 Series oscilloscopes. It is the only C-50 Series camera for the 7603. Many of the features of the high-priced C-50 Series cameras are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb and time operating modes, x-sync contacts, and film back interchangeability.

## C-59A CHARACTERISTICS

**Aperture** — Variable from f/2.8 fo 1/16.

**Magnification** — 0.67.

**Field of View** — 10.2 cm x 12.7 cm (wider with optional 016-0288-01 adaptor frame/corrector lens).

**Relative Light-Gathering Ability** — 0.65.

**Resolving Power** — Center: At least 10 lines/mm. Corners: At least 4 lines/mm.

**Shutter** — Mechanical; 1/125 to 1 s; bulb and time.

**Synchronization** — X-sync switch closure.

**Power Requirement** — Receives power (+15 V) from a 7000 Series oscilloscope, or from an internal battery pack, 8 AA size alkalines, (12 V) if used on a non-7000 Series oscilloscope.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 193 | 7.7 |
| Height | 292 | 11.5 |
| Depth | 273 | 10.8 |
| **Weights ≈** | **kg** | **lb** |
| Net | 3.2 | 7.0 |
| Shipping | 5.0 | 11.0 |

## ORDERING INFORMATION

"P" Models accept only Polaroid pack film. "G" Models have a Graflok type back that requires a film holder (see page 413 for film holders). C-59 does not include 8 AA size alkaline batteries.

**C-51G** **$2,360**

**Includes:** Mounting adaptor for all 7000, 5000, and small 600 Series (016-0249-06); camera visor (337-0411-02); Graflok film back (122-0931-01) with intregral focusing screen; instruction manual (070-1011-03).

**C-51P Camera** **$2,360**

**Includes:** Same as C-51G except it has a Polaroid pack film back (122-0926-02) instead of Graflok film back, and a focus plate (387-0893-02).

**C-53P Camera** **$1,940**

**Includes:** Same as C-51P.

**C-59AG Camera** **$1,335**

**Includes:** Sames as C-51G except instruction manual (070-3632-00).

**C-59AP Camera** **$1,335**

**Includes:** Same as C-59AG.

**C-59A Adaptor Frame w/Corrector Lens Kit** — Expands the field of view to fully cover the 6½ inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030 Series oscilloscopes. The slip-on corrector lens (352-0293-00) reduces the effective magnification of the C-59 from 0.67 to 0.5 so it can record the entire display on Polaroid 3½ in x 4½ in film (for the C-59A camera only.) Adapts camera to 576, 5030, and 5031. Order 016-0288-01 **$140**

## C-50 SERIES OPTIONAL CAMERA ACCESSORIES

**Mounting Adaptors** — See page 406.

**Battery Pack** — Provides auxiliary +15 V power source for using the C-51, C-53 Cameras with oscilloscopes without camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000 Series oscilloscope or an external +15 V source. Includes three pin female connectors for external power in (131-0716-00). Net weight, including batteries, is 1.2 lb. Requires 8 AA size alkaline batteries (not included). Order 016-0270-02 **$275**

**Writing Speed Enhancer** — Provides controlled film fogging to increase writing speed by 3X for 3000 ASA film and ⩾3.5X with 20,000 ASA film. Installs in minutes. See page 405 for more information.
For C-51 Order 016-0279-02 **$255**
For C-53 Order 016-0300-02 **$280**
For C-59A Order 016-0290-02 **$300**

**X-Sync Connector Plug** — Not shown.
Order 134-0079-00 **$1.30**

**Foot Switch** — For Remote Shutter Actuation of the C-51, C-53, with 8 ft cable.
Order 260-1189-02 **$22.50**

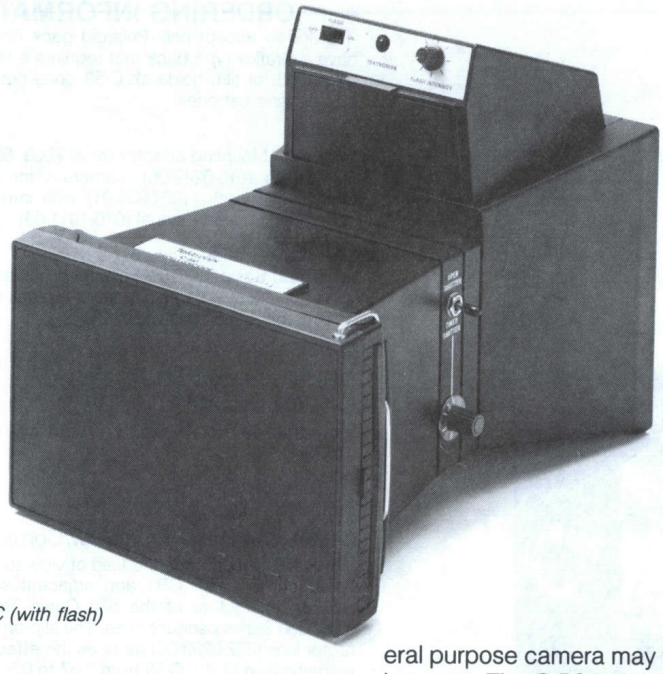
**Carrying Case** — Holds a complete C-50 Series camera with extra film backs and accessories. Order 016-0177-00 **$285**

**Polaroid Pack Film Back** — Included with "P" models. Order 122-0926-02 **$175**

**Focus Plate** — Included with "P" models.
Order 387-0893-02 **$4.00**

**Graflok Type Film Back** — Included with "G" models (see page 413 for film holders), accept Polaroid 4 in x 5 in film holders, standard cut-film holders, film-pack adaptors, roll-film holders*[1] (except heavy motorized models). Includes integral focusing screen.
Order 122-0931-01 **$250**

*[1] *Other film hodlers and adaptors (4 cm x 5 cm cut film, back film, or roll film) are available at local camera stores.*



*Standard C-5C (with flash)*

# C-5C

**Low Cost**

**Easy to Use**

**Mounts Onto Many Scopes and CRT-Based Instruments**

**Covers 8 cm x 10 cm or 9.8 cm x 12.2 cm CRT Displays**

**Fixed Focus**

**Lightweight and Compact**

**Interchangeable Adaptor Hoods**

**Built-In Flash on Some Models**

**OEM Pricing Available**

### Maximum Performance at Minimum Cost

If your application does not required specialized photographic techniques, such as the capability to record single sweeps, this general purpose camera may fill your needs at a low cost. The C-5C is lightweight and modular, with a reliable electronically activated shutter. The three-element f/16 lens offers both 0.67 and 0.85 magnifications, either of which you can easily change by reversing the lens/shutter module and the spacer module positions.

### Flash

A variable-intensity xenon flash that evenly lights CRTs with nonilluminated graticules comes on the C-5C and Options 03 and 04. It can be easily retrofitted on C-5Cs that do not have it.

### Viewing Door

Flash models have a small built-in door. Nonflash models replace the flash unit with a large lift-up viewing door (016-0630-00).

### Adaptor Hoods

Comes standard with camera (see below), and additional hoods can be ordered separately. Easily changed by removing four screws inside hood.

### Film

Uses Polaroid pack film, i.e., 667, 665 etc. See page 405 for other films.

Note: The C-5C and C-7 are separate camera systems, therefore a C-5C cannot be converted into a C-7 and vise versa. However, they do use the same hoods and flash assemblies.

### OEM Quantities

The low-cost C-5C Oscilloscope Camera is available in OEM quantities.

**Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.**

## CHARACTERISTICS

**Aperture** — Fixed at f/16.

**Lens** — Three glass elements.

**Magnification** — 0.67 or 0.85.

**Field of View** — 9.8 cm x 12.2 cm (0.67 magnification) or 8.0 cm x 10.0 cm (0.85 magnification).

**Relative Light-Gathering Ability** — 0.02.

**Shutter** — Electronic; 1/10 to 5 s; time.

**Power** — The C-5C requires (4) AA alkaline batteries (not included). Battery holder inside camera.

### PHYSICAL CHARACTERISTICS*1

| Dimensions | mm | in |
|---|---|---|
| Width | 168 | 6.6 |
| Height | 140 | 5.5 |
| Depth | 257 | 10.1 |
| **Weights ≈** | **kg** | **lb** |
| Net | 1.4 | 3.0 |
| Shipping | 1.9 | 4.1 |

**1 Standard C-5C.*

## ORDERING INFORMATION

**C-5C** Camera **$495**

**Includes:** Adaptor hood (016-0357-01); flash unit (016-0642-02); instruction manual (070-2824-00).

**OPTIONS**

**Option 01** — 016-0357-01 adaptor hood, no flash **−$30**

**Option 02** — 016-0359-01 adaptor hood, no flash **−$30**

**Option 03** — 016-0358-01 adaptor hood with flash **NC**

**Option 04** — 016-0359-01 adaptor hood with flash **NC**

## OPTIONAL ACCESSORIES

**Large Viewing Door** — Fits all three mounting adaptor hoods. (Included with C-5C Options 01 and 02.) Order 016-0630-00 **$7.00**

**Graticule Flash Unit** — Fits all three mounting adaptor hoods. (Included with C-5C and C-5C Options 03 and 04.) Order 016-0642-02 **$150**

**Additional Mounting Adaptor Hoods** — Requires flash unit or large viewing door.
(C-5C and C-5C Option 01.) Order 016-0357-01 **$20**
(C-5C Options 02 and 04.) Order 016-0359-01 **$20**
(C-5C Option 03.) Order 016-0358-01 **$20**

### C-5C SELECTION GUIDE

| Features | Standard C-5C | | C-5C Option 01 | | C-5C Option 02 | | C-5C Option 03 | | C-5C Option 04 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Flash Unit | ✓ | | | | | | ✓ | | ✓ | |
| Large Viewing Door | | | ✓ | | ✓ | | | | | |
| Adaptor Hood | 016-0357-01 | | 016-0357-01 | | 016-0359-01 | | 016-0358-01 | | 016-0359-01 | |
| **Dimensions*1** | **cm** | **in** | **cm** | **in** | **cm** | **in** | **cm** | **in** | **cm** | **in** |
| Height | | | | | | | | | | |
| Inside | 13.0 | 5.13 | 13.0 | 5.13 | 10.5 | 4.13 | 9.5 | 3.74 | 10.5 | 4.13 |
| Outside | 13.7 | 5.38 | 13.7 | 5.38 | 11.2 | 4.40 | 11.2 | 4.41 | 11.2 | 4.40 |
| Width | | | | | | | | | | |
| Inside | 14.2 | 5.60 | 14.2 | 5.60 | 12.0 | 4.74 | 11.8 | 4.65 | 12.0 | 4.74 |
| Outside | 14.9 | 5.85 | 14.9 | 5.85 | 12.7 | 4.99 | 13.1 | 5.14 | 12.7 | 4.99 |
| Compatibility | 577, 600 Series with nonilluminated graticule, 1420 Series, 5100 Series | | 528, 600 Series without graticule or with illuminated graticule, 5400 Series, 7000 Series, T922R, Telequipment D83 | | 432, 434, 455, 464, 465B, 465M, 466, 468, 475, 475A, 2400 Series | | T900 Series (except T922R) | | 2200 Series with nonilluminated graticule | |

**1 All dimensions are approximate since each hood has additional plastic notches and grooves for mounting.*





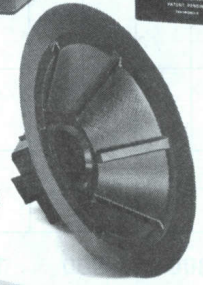
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

# DIGITAL PHOTOMETER/ RADIOMETER

J6523

J6501
J6502
J6503
J6504
J6505

J6511 (shown)
J6512



LIGHT OCCLUDER
016-0305-00

LED ADAPTOR w/ EXTRA LED HOLDER
(included with J6505)
014-0047-00

The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory, in the field, or on the production floor. A J16 System consists of a J16 mainframe and one of eight detachable probes. Probes can be either mounted on the J16 or used on the end of an extension cable. All probes have a HOLD switch to allow the reading to be held.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions.

All probes use silicon photo-diodes and multi-element glass filters for maximum stability and accuracy.

The optional BCD/analog output feature allows the user either a BCD output of the displayed reading or an analog signal (level) proportional to the light falling upon the sensor. The J-16 can be also used with Tek MI 5010/50M30 system for interface with a GPIB system.

Under normal usage, the internal rechargeable nickel cadmium batteries will operate the J16 for four hours. An ac power supply is recommended for continuous operation.

## CONTENTS

J16 Photometer/Radiometer ..... 417
Illuminance Probes ..... 419
Irradiance Probes ..... 419
Luminance Probes ..... 419
Uncorrected Probe ..... 420
LED Test Probe ..... 420

## J16 Photometer/Radiometer

**Digital LED Readout**

**Eight Silicon Sensor Probes Quickly Interchange without Recalibration**

**Freedom from Saturation Effects over Entire Range**

**Accurate Spectral and Cosine Corrections**

**Metric and US Versions Available**

**BCD/Analog Output (Option 07)**

**Ac or Internal Rechargeable Battery Versions**

**Longer Battery Life—4 Hour Operation**

**Application Notes Available**

Power supplies or battery packs can be changed quickly by removing four screws on the J16's rear panel. The cabinet and probes have an internal threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

### J16-TV Package

The J16-TV package is an excellent transfer mechanism which provides a simple, accurate method for adjustment of monitor screen color temperature. The primary colors are measured and adjusted to produce white color temperature balance.

The J16-TV with optional J6503 or J6523 measures monitor screen brightness on both color and black and white monitors. Other applications include measurement of studio lighting, camera lighting, and illumination of work areas.

The J16-TV package includes: J16 Battery-operated Photometer, J6502 Irradiance Probe, light occluder, probe extension cable, and battery charger. See application note (58A-2926-1) for additional information.

## GLOSSARY

**Photometry** — The measurement of light visible to the human eye.

**Radiometry** — The measurement of light within the total optical spectrum.

**Color Temperature** — The temperature of a blackbody whose radiation has the same visible color as that of a given non-blackbody radiator. Usually expressed in °k.

**Foot-candle** — Unit of incident illumination.

**Foot-lambert** — A unit of illumination emitted or diffusely reflected by a source.
Two additional units are commonly used—the lux (the metric unit of illuminance) and the nit (the metric unit of luminance).
1 foot-candle = 10.76 lux
1 foot-lambert = 3.426 nits

**Illuminance** — The amount of luminous flux through a unit of surface area and is usually measured in foot-candles (lumens/ft²).

**Inverse Square Law** — The decrease of light intensity with increasing distance. Twice the distance, reduces the illumination to one-quarter.

**Irradiance** — The amount of radiant flux received by a unit of surface area and is usually measured in watts/cm²*¹.

*¹ *Other units of irradiance such as μW/cm² and W/m² are also used extensively.*

**Lambert's Law** — Describes the spatial characteristics of a perfectly diffusing surface which may be either emitting or reflecting light. The light emitted or accepted by such a surface decreases with angle (from perpendicular) according to the cosine of the angle.

**Luminance** — The amount of light emitted or scattered by a surface and is usually measured in foot-lamberts.

**Photopic** — Spectral (color) sensitivity of the average human eye, predominantly peaked in the yellow-green region.

**Steradian** — A unit of area on the surface of a sphere equal to the radius squared. There are 12.6 steradians total area on a sphere.

**Spatial** — The directional characteristics of light in space.

**Spectral** — The distribution of light by wavelength within an electromagnetic spectrum.

*Note that each radiometric unit has a photometric equivalent differing only in spectral response of the sensor. However, the units are not interchangeable.*

## PROBE CHARACTERISTICS

| Application | | Illuminance | | Irradiance | Luminance | | Uncorrected | Red LED |
|---|---|---|---|---|---|---|---|---|
| Probe | | J6501 | J6511 | J6502/J6512 | J6503 | J6523 | J6504 | J6505 |
| Range | US*² | 0.001 to 1999 footcandles*¹ | 0.001 to 1999 footcandles | 0.001 to 1999 microwatts/cm² | 0.1 to 199,900 footlamberts*¹ | 0.1 to 19,990 footlamberts*¹ | Relative response only | 0.001 to 1999 footcandles*¹† |
| | Metric (Opt. 02)*² | 0.01 to 19,990 lumens/m² (lux)*¹† | 0.01 to 19,990 lumens/m² (lux) | 0.01 to 19.990 milliwatts/m² | 1 to 1,999,000 candelas/m² (Nits)*¹ | 1 to 199,900 candelas/m² (Nits)*¹ | Relative response only | 0.01 to 19,990 lumens/m² (lux)*¹† |
| Accuracy (Including J16) | | Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS | | Same as J6501, except calibrated with a 762 nm filter | Within 5% of NBS standards and ±1 digit in last place. Calibrated with a 3100° k tungsten halogen light source traceable to NBS | | Probe-to-probe accuracy ±5% with tungsten light source | Same as J6501, except calibrated with a 656 nm filter |
| Spectral Response | | Within 2% (integrated) of CIE photopic curve | | Flat within ±7% from 450 to 950 nm | Within 2% (integrated) of CIE photopic curve | | UV enhanced silicon spectral curve (250 to 1200 nm) | Within 2% (integrated) of CIE photopic curve from 600 to 710 nm |
| Acceptance Angle | | 50% sensitivity at 48° off axis | Cosine corrected (180°) | 50% sensitivity at 48° off axis | 8° | 1° | 50% sensitivity at 48° off axis | |
| Stability and Repeatability | | Within 2% per year | | | | | | |
| Linearity | | Within 2% over entire range enabling single point calibration | | | | | | |

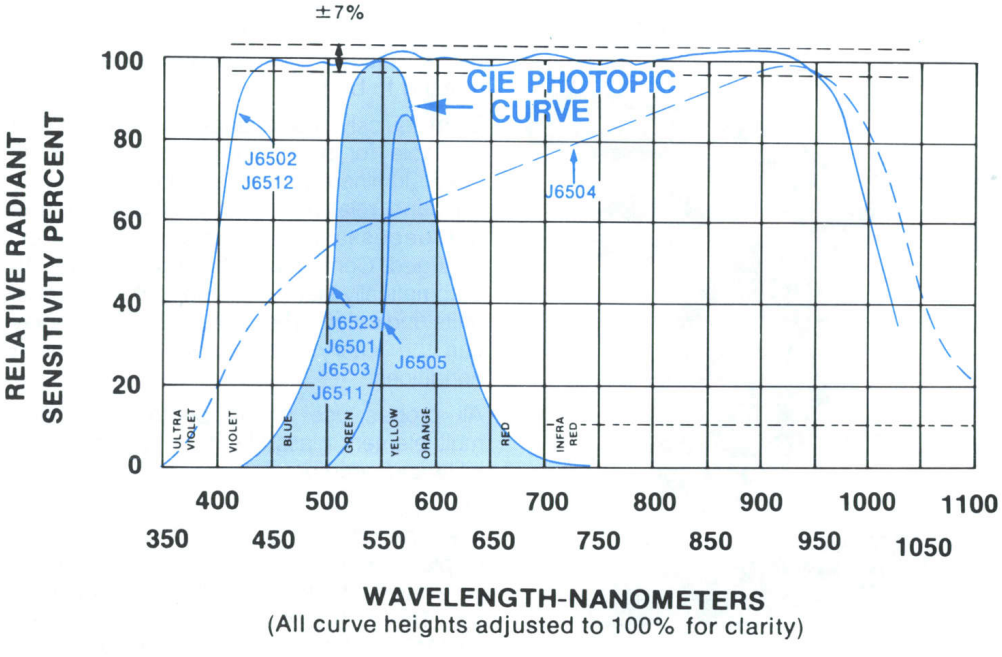
*¹ *An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.*

† *0.00001 to 199.9 candelas when used with 014-0047-00 LED adaptor or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles x d²=candelas where d is the distance from the source to the sensor in feet. (For metric readings use lux x d²=candelas where d is distance from the source to the sensor in meters.) Request J16 Application Notes 58A-2635 and 58A-2704-1 for further information.*

*² *U.S./METRIC CONVERSIONS*

| | *U.S. to Metric* | *Metric to U.S.* |
|---|---|---|
| *Illuminance* | *Fc x 10.764 = Lux* | *Lux x 0.0929 = Fc* |
| *Luminance* | *Fl x 3.426 = Nits* | *Nits x 0.2919 = Fl* |

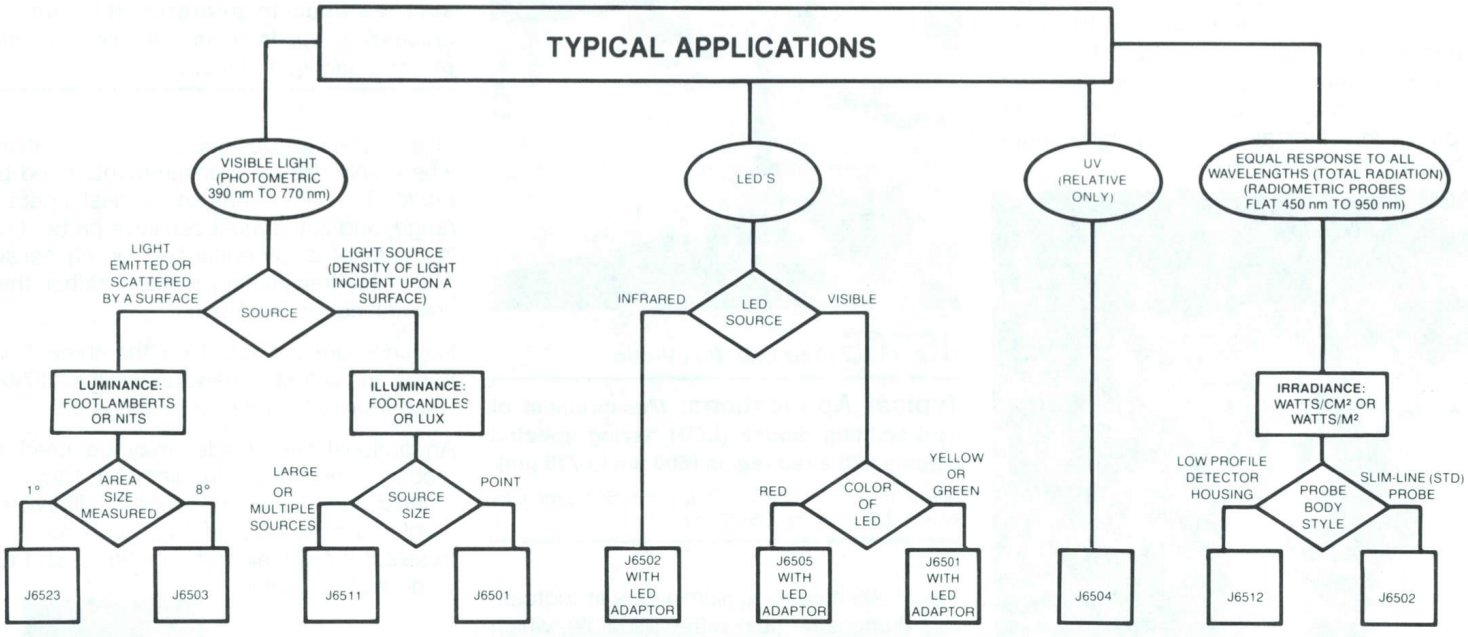
## TYPICAL PROBE SPECTRAL CHARACTERISTICS




*NOTE: C.I.E. stands for the International Commission on Illumination.*

## J-16 PROBE SELECTION GUIDE

The following flowchart is an aid in selecting J-16 probes. The applications for the probes are too numerous to list, but this should help in your selection.




## J6511/J6501

### Illuminance Probes

**Typical Applications: Measurement of roadway illumination, office lighting, illumination of work surfaces, studio lighting, camera setup, and yellow and green LED testing.**

The J6511 is an illuminance probe with readout in footcandles (lumens/m² (lux) for the J6511 Option 02). A multi-element glass filter and silicon photo-diode insure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe head and J16 allows the user to be out of the field of view while making measurements.

Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction and units as the J6511. The J6501 with the LED adaptor can be used to measure green and yellow LEDs.

*J16-TV System with J6502 being used for color monitor setup.*

## J6502/J6512

### Irradiance Probes

**Typical Applications: Laser research experiments, measurements of radiant efficiency, color CRT set-up, and infrared LED testing.**

The J6502/J6512 measure irradiance in microwatts/cm² (millwatts/m² with Option 02). The spectral response is flat from 450 nanometers to 950 nanometers, ±7%. The response is typically down 50% at 400 nm and 1030 nm.

An optional filter holder is available for the J6502 to mount standard 1 inch diameter customer-supplied filters of up to ⅜ inch thickness. Where high intensity sources are used (over 1990 μwatts/cm²), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.). These filters may be held with an optional filter holder.

Where the 1 sq cm sensor is not completely filled by the source for example with a laser beam, the reading obtained represents μwatt instead of μwatts/cm² or milliwatts x $10^{-4}$ instead of milliwatts/m² (Option 02). Small variations in sensor uniformity may add ±5% uncertainty to this measurement.

The J6512 has a low-profile detector head that is at the end of a six foot cable. Longer cables can be ordered as a special modification.

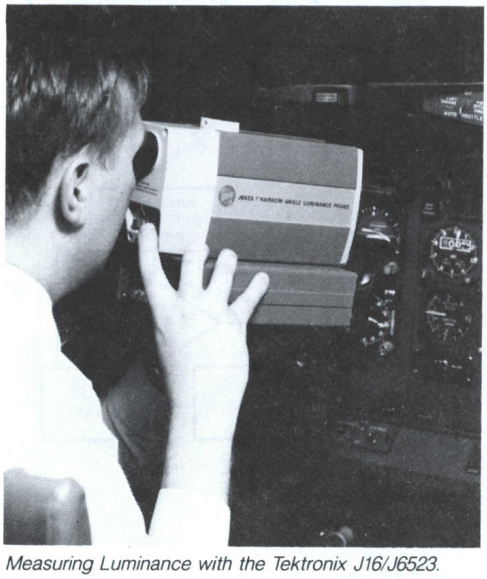
## J6503 8° Luminance Probe

**Typical Applications: Measuring brightness of video screens, street signs, light reflected from work surfaces, and movie screens**

The J6503 measures luminance in footlamberts (candelas/m² (nit) with Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (Option 02) indicator automatically lights when the J6503 is connected.



*Measuring Luminance with the Tektronix J16/J6523.*

## J6523 1° Luminance Probe

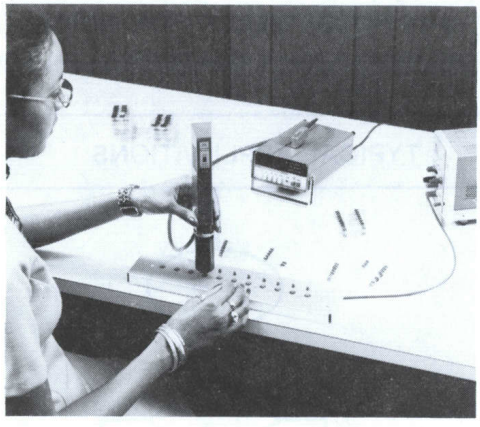
**Typical Applications: Measuring highway lighting, video displays, photographic equipment, and lighting equipment.**

The J6523 will measure the luminance in foot-lamberts (candelas/m² with Option 02) of a spot as small as 0.32 inch in diameter. By using commercially available 55 mm stackable diopters, areas as small as 0.035 inch (+10 diopters) can be measured. These 55 mm diopters are physically similar to threaded 55 mm filters, and are available from most photography stores. (See application note 58AX-3252).

The 1° angle represents 0.21 inch per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1 inch diameter spot.

The probe includes an optical sighting system with a 9° viewing field. The focusing range is 18 inches to infinity, closer with 55 mm close-up diopters. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources.

The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard ¼ in x 20 threaded socket allows it to be used on a tripod or an optical bench.



## J6505 Red LED Test Probe

**Typical Applications: Measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 nm to 710 nm).**

*Note: For yellow or green LEDs use the J6501 probe, for infrared LEDs use the J6502 probe.*

The J6505 measures illuminance in footcandles (lumens/m² (lux) with Option 02), which can easily be converted into luminous intensity in candelas. (See application notes 58A-2635 and 58A-2704-1.)

An adaptor supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adaptor excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adaptor to fit common sizes of LEDs (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adaptor in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m² represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 nm to 710 nm. This close match requires compromising in the 380 nm to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the LED adaptor must be used with the J6501 and the same conversion factor for luminous intensity applies.

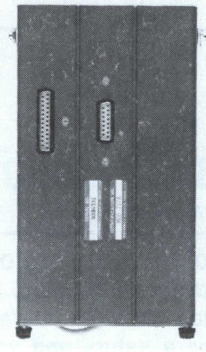
## J6504 Uncorrected Probe

**Typical Applications: Checking light sources used in photoresist or photoprocessing applications, and comparisons of ultraviolet light sources.**

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters.

No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

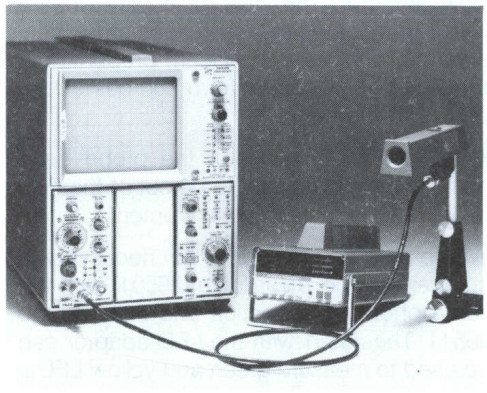


*J16 WITH ANALOG BCD OUTPUT (OPTION 07)*

## Option 07 BCD/Analog Output

The J-16 is equipped with a 25-pin connector on the unit's top. This provides parallel TTL logic anc BCD outputs, a "hold" input line (TTL), and an analog signal output (0 to −2 V or 0 to −6 V), depending on the range, for a full-scale readout. The analog bandwidth is approximately 0.8 Hz.

A cable-end connector and cover have been added to the accessories complement.



*J16 probe used to measure pulsed light source.*

## CHARACTERISTICS

### J16 Mainframe
### (See Probes on previous pages)

**Display —** 3½-digit LED readout and three LEDs automatically indicating correct units for probe in use. Metric version readout is also available (Option 02).

**Stability —** Within 2% per year.

**Linearity —** Within 2% over the entire range, enabling single point calibration.

**Integration Time —** ≈100 ms.

**Calibration —** Electrical calibration of the J16 mainframe is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

### POWER REQUIREMENTS

**Standard and Option 01 —** Has internal rechargeable NiCad batteries that require 16 hours for a full charge. The J16 will operate nominally four hours continuously on a charge. The J16 cannot be operated from the battery charger for continuous operation since the charging rate is ≈200 mA, while the J16 draws ≈400 mA. For continuous operation an ac power supply is recommended.

**Option 03 and Option 04 —** Ac only operation, no internal batteries.

### J-16 AND PROBES ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature —** Nonoperating: −50°C to +75°C. Operating: −15°C to +40°C.

**Altitude —** Nonoperating: To 15,000 m (50,000 ft). Operating: To 4600 m (15,000 ft).

**Humidity —** Operating and Storage: Five cycles (120 hour) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

**Vibration —** Operating: 15 minutes along each of the three major axes at a total displacement of 0.025 in p-p (4 g's) from 10 Hz to 55 Hz to 10 Hz in one minute cycles. Hold for three minutes at 55 Hz. All major resonances must be above 55 Hz.

### PHYSICAL CHARACTERISTICS WITH PROBE AND BATTERY PACK INSTALLED

| Dimensions | mm | in |
|---|---|---|
| Width | 123 | 4.6 |
| Height | 60 | 2.4 |
| Depth | 203 | 8.0 |
| **Weights ≈** | **kg** | **lb** |
| Net | 1.5 | 3.3 |
| Domestic Shipping | 2.3 | 5.0 |
| Export-packed | 4.5 | 10.0 |

## ORDERING INFORMATION

**(PROBES NOT INCLUDED UNLESS NOTED)**

**J16** Photometer/Radiometer Battery Version, with 115 V ac, 50 Hz to 400 Hz **$1,260**

**Includes:** Battery charger (119-0375-02); shoulder strap (346-0104-00); battery pack (016-0539-01); nonmetric version instruction manual (070-1879-00); or with Option 02 metric version instruction manual (070-1880-00).

**J16-TV** Photometer/Radiometer Package for TV Color CRT Set-up **$1,880**

**Includes:** Same as J16 plus J6502 irradiance probe, light occluder (016-0305-00), 42 inch probe extension cable (012-0414-02).

### OPTIONS (J16/J16-TV)

**Option 01 —** Battery version with 230 V ac, 50 Hz to 400 Hz charge. **NC**

**Includes:** Same as J16/J16-TV except battery charger 119-0375-03 is substituted.

**Option 02*1 —** Metric Readout. **NC**

**Option 03 —** 115 V ac Only Operation, 50 Hz to 400 Hz. **NC**

**Includes:** Ac power pack (119-0404-00); shoulder strap (346-0104-00); nonmetric version instruction manual (070-1879-00); or with Option 02, metric version instruction manual (070-1880-00).

**Option 04 —** 230 V ac Only Operation, 50 Hz to 400 Hz. **NC**

**Includes:** Same as Option 03 except it has ac power supply 119-0404-01 substituted.

**Option 07 —** BCD/Analog Output. **$80**

**1 Option 02 must also be ordered for probes.*

### PROBES

**J6501** Illuminance Probe **$590**

**J6502** Irradiance Probe **$590**

**J6503** 8° Luminance Probe **$590**

**J6504** Uncorrected Probe **$550**

**J6505** LED Probe, Includes LED Adaptor and 3 LED Holders **$590**

**J6511** Illuminance Probe, Cosine Corrected (with 25 ft cable) **$570**

**J6512** Irradiance Probe (with 6 ft cable) **$575**

**J6523** 1° Luminance Probe **$1,670**

### PROBE OPTIONS

**Option 02 —** Metric probes required for metric readout J16s (Option 02). **NC**

**Option 05 —** Actual spectral curve of any probe (available on initial order). **+$40**

## OPTIONAL ACCESSORIES

**42 in Probe Extender Cable —** Connects J16 to probe. Order 012-0414-02 **$105**

**Probe Extender Cables —** Up to 30 ft in length are available on special order through your local Tektronix sales office.

**Light Occluder —** For TV color CRT balancing. Order 016-0305-00 **$25**

**Filter Holder —** Mounts 1 in diameter filters, of up to ⅜ in thickness*1, to probes (except J6511, J6512, J6523). Order 016-0527-00 **$30**

**LED Adaptor —** With 3 LED Holders (included with J6505). Order 014-0047-00 **$85**

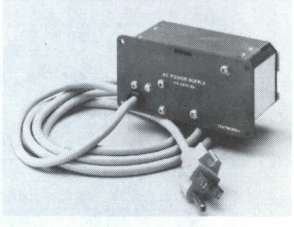
**Tripod —** Order 016-0253-00 **$135**

**1 Filters available from vendors such as: ORIEL (203) 377-7877 or CORION CORP. (617) 429-5065 and others.*

### Power Packs

Power packs can be quickly changed by removing four corner screws on the J16's rear panel and sliding the power supply or battery pack out.

**Ac Power Supply**

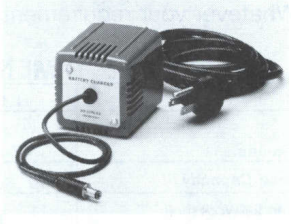


**Ac Power Supply —** Allows J16 to be used without batteries.
Order 119-0404-00 115 V ac, 50 Hz to 400 Hz (included with Option 03). **$230**
Order 119-0404-01 230 V ac, 50 Hz to 400 Hz (included with Option 04). **$240**

**Battery Pack**

**Spare Battery Pack —** Order 016-0539-01 **$155**

**Battery Chargers**



When ordering a battery pack for your ac-powered J16, also order one of the following chargers.

**Battery Charger —** 115 V ac, 50 Hz to 400 Hz. (Included with Standard J16.)
Order 119-0375-02 **$60**

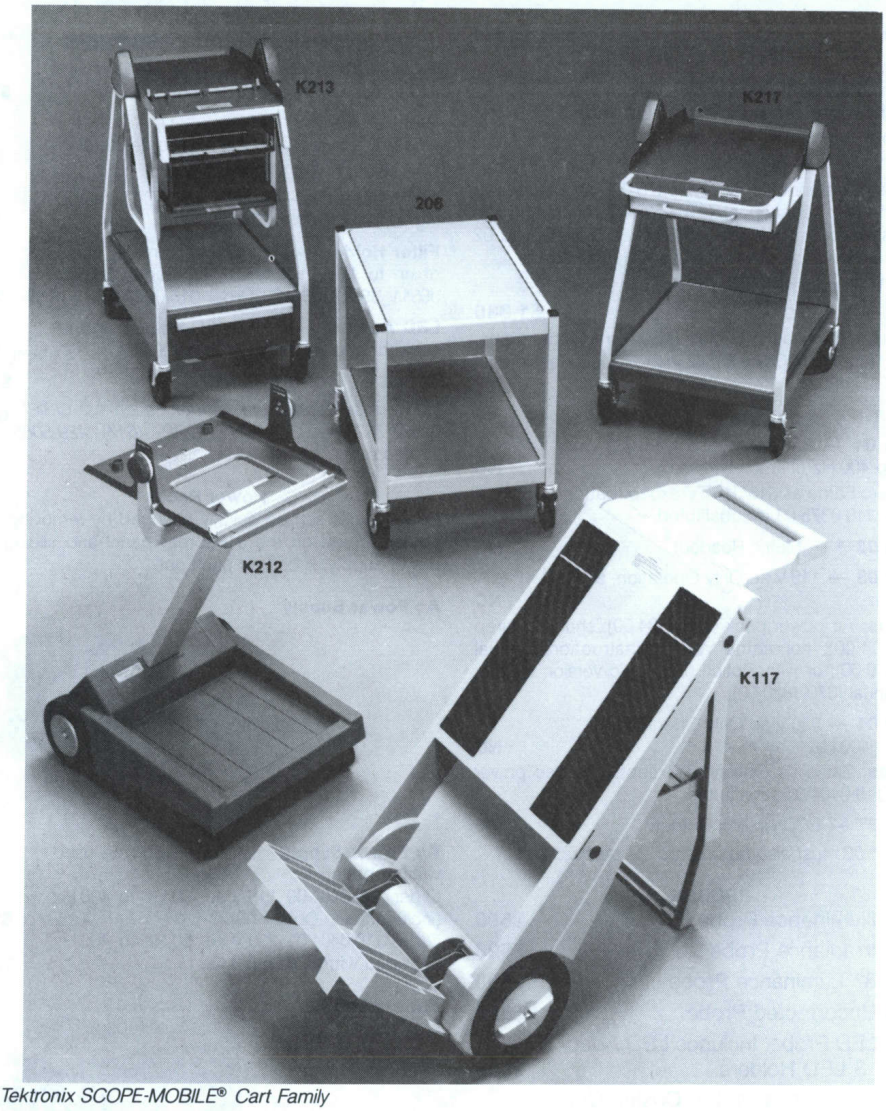
**Battery Charger —** 230 V ac, 50 Hz to 400 Hz. (Included with Option 01.)
Order 119-0375-03 **$60**

Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Sales Office or Representative regarding special application requirements.

## J16 APPLICATION NOTES

These can be obtained from your local Tektronix representative.

| DESCRIPTION | REQUEST NO |
|---|---|
| Photometry/Radiometry primer, and standardizing CRT measurements. | 60W-5750 |
| Luminous intensity and visible LED measurements with the Tektronix J16 Photometer. | 58A-2635 |
| Measuring pulsed light sources with the J16 and an oscilloscope. | 58A-2702-1 |
| Radiant intensity and infrared emitting diode measurements. | 58A-2704-1 |
| Television station applications for the J16 Photometer. | 58AX-2764-1 |
| Practical lighting measurements with the Tektronix J16. | 58A-2912 |
| TV picture monitor color temperature adjustment using the Tektronix J16. | 58A-2926-1 |
| Photographic exposure measurements with the Tektronix J16. | 58AX-3060-1 |
| Measuring the luminance of small areas of light with the J16 and J6523. | 58AX-3252 |
| Optical communications measurements. | 58AX-3602 |




*The Tektronix SCOPE-MOBILE® Cart Family*

Tektronix SCOPE-MOBILE® Carts give the quality and versatility needed by many test instrument users.

Tek carts free up your valuable table space and make sharing equipment between work benches easy. They are designed for easy integration into your instrument systems. OEM pricing is available for most models.

Whatever your requirements, Tek has a cart to fit your needs.

## DIMENSIONS/LOAD CAPACITY/WEIGHTS

| | K117 | | K212 | | K213 | | K217 | | 206 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | 17 x 33 | | 13 x 17 | | 13.7 x 20<br>13 x 20 (shelf) | | 18 x 27 | | 27.6 x 22 | |
| **Load Capacity** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** | **kg** | **lb** |
| Handle/Workshelf | 11 | 25 | — | — | — | — | — | — | — | — |
| Tool Shelf | 18 | 40 | — | — | — | — | — | — | — | — |
| Frame | 36 | 80 | — | — | — | — | — | — | — | — |
| Top Tray | — | — | 36 | 80 | 34 | 75 | 45 | 100 | 45 | 100 |
| Base | — | — | 45 | 100 | 11 | 25 | 45 | 100 | 45 | 100 |
| Hanging Shelf | — | — | — | — | 18 | 40 | — | — | — | — |
| Total | 54 | 120 | 82 | 180 | 77 | 170 | 90 | 200 | 90 | 200 |
| **Weight** | | | | | | | | | | |
| Net | 14 | 30 | 9 | 20 | 26 | 57 | 20 | 43 | 14 | 30 |
| Shipping | 17 | 38 | 13 | 28 | 34 | 75 | 26 | 57 | 17 | 38 |
| **Page** | 423 | | 423 | | 424 | | 424 | | 423 | |
| **Prices** | $265 | | $330 | | $595 | | $495 | | $235 | |

## INSTRUMENT/CART COMPATABILITY

✓ — Recommended  x — Compatible

| | K117 | K212 | K213 | K213 Shelf | K217 | 206 |
|---|---|---|---|---|---|---|
| **Terminals/Copiers/Monitors** | | | | | | |
| 4000 Series | | | | | | ✓ |
| 4611/4612 | | | | | | ✓ |
| 4631/4632 | | | | | | ✓ |
| 4634/4635 | | | | | | ✓ |
| 4644 | | | | | | ✓ |
| 4660 Series | | | | | | ✓ |
| 4695 | | | | | | ✓ |
| 4900 | | | | | | ✓ |
| 4926/4970 | | | | | | ✓ |
| 606B/608/620 | x | x | | x | | |
| 650 HR Series (Cabinet) | | | | | ✓ | x |
| 670 Series | | | | | ✓ | x |
| **Logic Analyzers** | | | | | | |
| 1240/1241 | ✓ | ✓ | x | | | |
| 308/318/338 | x | x | | x | | |
| DAS 9100/9200 | x | | | | ✓ | x |
| **Television/Spectrum Analyzers/Cable Testers** | | | | | | |
| 1410R Series | x | | | | ✓ | x |
| 1420 Series | x | ✓ | | | | |
| 1430/1440 | x | | | | ✓ | x |
| 1450/1470 Series | x | | | | ✓ | x |
| 1480 Series Cabinet | x | ✓ | | x | | |
| 1480 Series Rackmount | x | | | | ✓ | x |
| 1740/1750 Series | x | ✓ | | x | | |
| 1910 (Cabinet) | x | | | | ✓ | x |
| 380 | x | ✓ | | x | | |
| 528A | x | ✓ | | x | | |
| R140 Series | x | | | | ✓ | x |
| R520 Series | x | | | | ✓ | x |
| 1500 Series | ✓ | x | | | | |
| OF150 Series | ✓ | x | | | | |
| 490 Series | ✓ | ✓ | | | | |
| **Oscilloscopes/Digitizers/Controllers** | | | | | | |
| 7000/5000 Series (Cabinet) | | | ✓ | | | |
| 7000/5000 Series (Rackmount) | x | | | | ✓ | |
| 530/540/550/ 560 Series (Cabinet) | | | ✓ | | | |
| 530/540/550/ 560 Series (Rackmount) | | | | | ✓ | |
| 2200/2300/ 2400 Series | x | ✓ | x | | | |
| 305/314/336 | x | x | | x | | |
| 400 Series | x | ✓ | x | | | |
| T900 Series | x | ✓ | | | | |
| 390AD | x | | | | ✓ | x |
| 7612D/7912AD | x | | | | ✓ | x |
| 7D20T | x | ✓ | | ✓ | | |
| 4041 | x | ✓ | | ✓ | | |
| **TM5000/TM500 Series** | | | | | | |
| TM5003/TM503/ TM504 | ✓ | x | x | ✓ | | |
| TM5006/ TM506/TM515 | ✓ | | | | ✓ | x |
| **Curve Tracers** | | | | | | |
| 576/577 | | | x | | ✓ | x |





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## K117 Instrument Shuttle

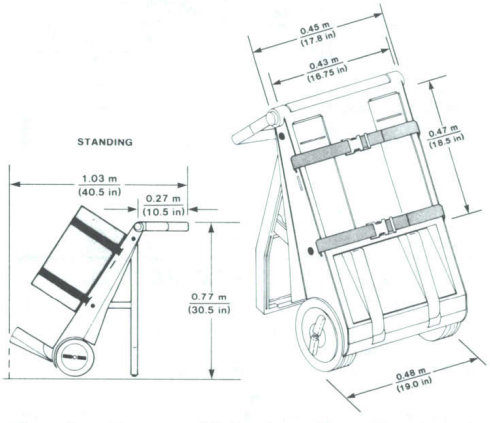
### Recommended For:

Medical; telecommunications; electronic equipment service; mobile test systems; inter-site mobility of instrumentation, tools, parts kits; on-site workstations.

The K117 Instrument Shuttle transports instruments and accessories in a self-contained unit, is easily moved between sites, and doubles as a work-station once on-site. Features include adjustable handle/work-shelf, wheel brakes, and optional pouch and rain cover.

K117 Data Sheet 56W-5694-1 is available.

### CHARACTERISTICS




**Construction** — High strength polycarbonate structural foam with textured vapor polish finish.

**Color** — Smoke tan.

### ORDERING INFORMATION

**K117** Instrument Shuttle **$265**

**Includes:** Two 2 in x 6 ft securing straps (346-0208-00); instruction sheet (070-5109-00).

### OPTIONAL ACCESSORIES

**Rain Cover** — Smoke-gray water-repellant nylon cover with pull cord. Covers and protects a loaded K117. Order 200-3051-00 **$26**

**Pouch** — Black nylon, two-zippered pouch attaches to the K117 support with four snaps. Convenient access and storage for small items. Order 016-0800-00. **$30**

**Securing Strap** — Black nylon webbed, 2 in x 6 ft. Order 346-0208-00. **$3.50**

## K212 Portable Instrument Cart

### Recommended For:

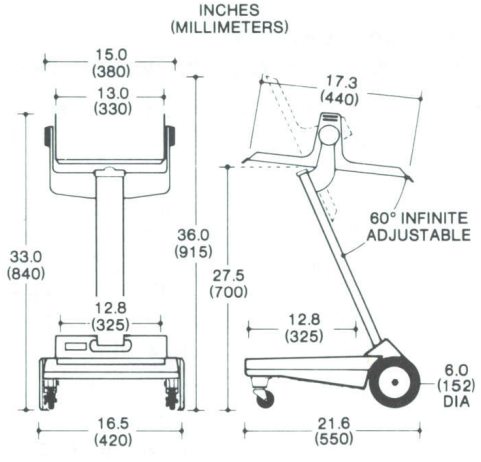
On-site mobility of all portable instruments.

The K212 provides a stable yet mobile platform for all Tek portable oscilloscopes and most other portable instruments. This cart is well suited for on-site mobility in medical facilities, labs, computer rooms, manufacturing areas, and other work areas.

Tilting top tray, large locking front casters, and wide track base are standard features. Two bolt assembly required.

K212 Data Sheet 56W-5835 is available.

### CHARACTERISTICS




**Construction** — Base of thermoset polyester. Column and top of tray made of high-strength aluminum.

**Color** — Base and tray are Tek blue. Column and yolk are silver gray.

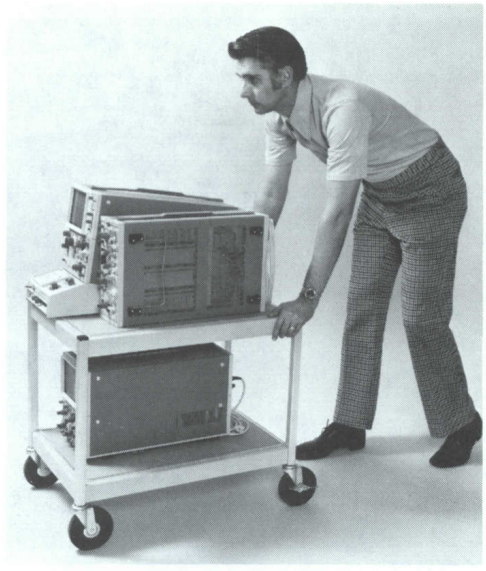
### ORDERING INFORMATION

**K212** Portable Instrument Cart **$330**

**Includes:** Two 1 in x 5 ft securing straps (346-0049-04); retaining bar (650-1881-00); two 3/16" bolts; 3/16" Hex key; instruction sheet (070-5554-00).

### OPTIONAL ACCESSORIES

**Securing Strap** — Black nylon webbed, 1 in x 5 ft. Order 346-0049-04 **$2.85**



## Model 206/206D Utility Cart

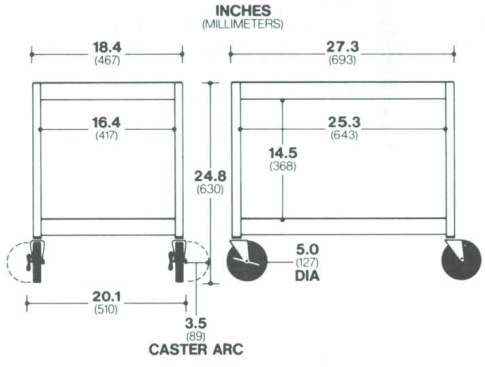
### Recommended For:

General instruments, computer peripherals, laboratory and office use.

The 206 and 206D are for general purpose use and mobility of instruments.

Features include a vinyl laminate on both surfaces and brakes on front casters.

### CHARACTERISTICS




### ORDERING INFORMATION

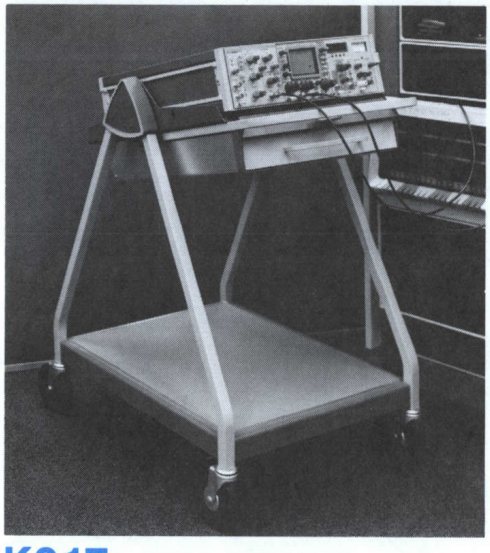
**206** Light Gray Finish **$235**

**Includes:** Instruction sheet (062-1408-02).

**206D** Brown Vinyl Finish **$235**

**Includes:** Instruction sheet (062-6617-00).

**Special terms, conditions and discounts are available to qualified OEMs on the K117, K212, and K217 carts. Contact your local Tek sales office.**



## K217 Rack Instrument Cart

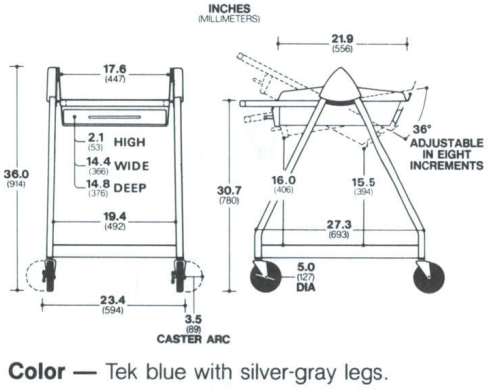
### Recommended For:

Most rackmountable or rack-width instruments.

The K217 directly replaces the 205/205D carts. It provides mobility for most rackmountable or rack width instruments (ears of rackmountable instruments hang over sides of tray).

Standard features include a tilting top tray, storage drawer under the top tray, a four outlet power strip, and front locking casters.

### CHARACTERISTICS




**Color** — Tek blue with silver-gray legs.

### ORDERING INFORMATION

**K217** Rack Instrument Cart **$495**

**Includes:** Instruction sheet (070-5653-00).

**Option 01** — Brown Finish **NC**

### OPTIONAL ACCESSORIES

(Fits K217 and 205/205D Carts)

**Securing Strap** — Nylon webbed, 1½ inch x 53 inch to secure instruments to top tray.

Blue for K217. Order 346-0070-01 **$65**

Brown for K217 Option 01. Order 346-0070-03 **$65**

OEM terms available on this product.

*K213 shown with Option 22.*

## K213 Lab Instrument Cart

### Recommended For:

5000 Series and 7000 Series Oscilloscopes.

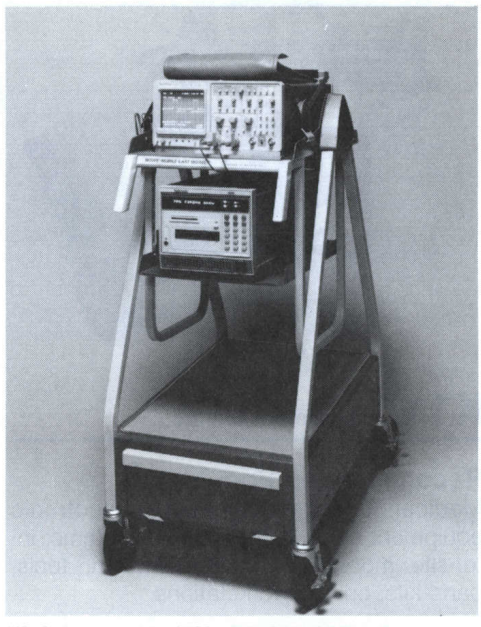
K213 directly replaces Model 3 Lab Cart. It is especially well suited for laboratory and manufacturing environments.

Standard features include tilting top tray, brakes on all casters, lockable drawer in the base, four outlet power strip, 7000 Series scope lock-down bar, mounting hardware for TM 500 equipment and older scopes, a hanging shelf and a securing strap.

The hanging shelves are supported underneath and tilt with the top tray. These shelves are large enough to carry a TM 504 system or other small-to-medium sized test instruments. Slots in the shelves allow instruments to be secured with straps.

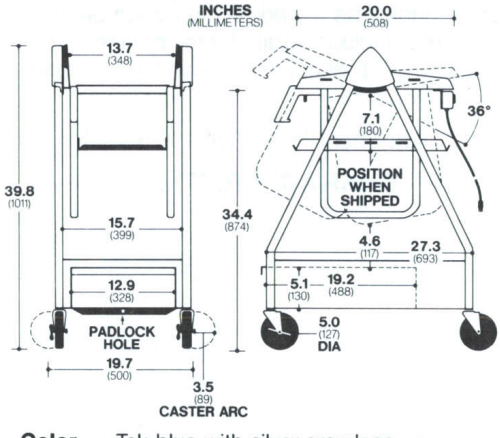
Option 10 provides a sliding drawer for use with the 7854 keyboard. The keyboard drawer mounts underneath the top tray and reduces available hanging shelf space by approximately three inches.

Option 12 gives an enclosure mounted on the standard shelf for storage of unused 5000 or 7000 Series plug-ins. The storage cabinet mounts on or under a shelf, but the option and kit do not include a shelf. Up to two storage cabinets are installable at a time.



*K213 shown with a 2430 and 4041 system.*

### CHARACTERISTICS




**Color** — Tek blue with silver-gray legs.

### ORDERING INFORMATION

**K213** Lab Instrument Cart **$595**

**Includes:** Securing strap, 1½ in x 42 in (346-0136-01); shelf (436-0132-01); miscellaneous mounting adaptors; four outlet, 115 V ac power strip; instruction sheet.

#### OPTIONS

**Option 05** — Delete Power Strip. **NC**

**Option 10** — 7854 Keyboard Drawer. **+$180**

**Option 12** — 5000/7000 Series Plug-in Storage Cabinet. **+$120**

**Option 22** — Combines Options 10 and 12. **+$285**

### OPTIONAL ACCESSORIES

(Fits K213 and Model 3 Carts)

**Securing Straps** — Black nylon webbed, for use on top tray, shelves, or base.

1½ in x 42 inch. Order 346-0136-01 **$26**

1½ in x 57 inch. Order 346-0156-01 **$26**

**Extra Shelf** — Mounts below top tray. Order 436-0132-01 **$50**

**7854 Keyboard Drawer Kit** — (Option 10 in kit form) Mounts under top tray. Order 436-0197-00 **$195**

**Plug-in Storage Cabinet Kit** — (Option 12 in kit form) Mounts on or under hanging shelves. Does not include shelf. Order 436-0196-00 **$125**

**Retaining Bar** — Used to prevent sliding of portable oscilloscope on top tray or shelf when secured by straps. Mounting hardware included. Order 650-1881-00 **$12.00**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

# THE STRONGEST LINK BETWEEN YOUR TEK INSTRUMENT AND RESULTS

Tek instruments are designed for users who place a premium on equipment quality and on reliability of results. Tek probes are engineered, assembled and tested to provide the most compatible link possible between tests instruments and the circuits under test.

## THE ABCs OF PROBES

This comprehensive primer on signal acquisiton probes contains sections on understanding probe specifications and applications and how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature *60W-6053* or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

## PROBES: SELECTION CRITERIA

**No factor is more critical to optimized system performance than proper probe selection.** A probe that's not right for your application can mean a significant loss in measurement results, plus costly delays and errors.

**For over 35 years, Tektronix has been designing probes that are matched not only to our scopes, but to your own instrument and application needs.** They minimize circuit loading, while extending and enhancing system performance.

By extending our resistive-wire, center-conductor cable technology, Tek 10X Passive probes can transfer a signal frequency that exceeds 300 MHz and presents only an added 3 pF per meter of cable to a circuit.

Tek probe products include active voltage probes, active and passive current probes, high voltage probes, low impedance/high frequency probes, and differential probes.

Bandwidth/risetime, input voltage, input impedance and limiting aberrations are all characteristics to evaluate in terms of your own application.

While electrical considerations are of major importance in your selection, physical parameters, such as probe length and proper tip adaptor, can be equally crucial. Unnecessary cable length, for example, will decrease bandwidth and increase the loading capacitance of the probe.

You'll find a wide variety of adaptors and probe tips available which feature Tek's special alloy coating that minimizes low current conduction problems. All are inherent to the Tek modular probe concept that lets you snap tips and other probe parts together without tools, so maintenance and repair of damaged probes is of minimal expense.

**Quick Delivery**

*NEW* The following probes are now ready to ship within 24 hours:

P6101A 1X, 2m. Order 010-6101-13

P6105A 10X, 2m. Order 010-6105-13

P6106A 10X, 2m. Order 010-6106-13

P6122 10X, 1.5m. Order 010-6122-01

P6131 10X, 1.3m. Order 010-6131-01

See pages 430-431, 433.

**To order call 1-800-426-2200.**

# CONTENTS


Probe Reference ..... 428
Passive Voltage Probes ..... 429
Active Probes ..... 434
Isolation/Floating Measurement Products .. 436
Differential Probes ..... 439
High Voltage Probes ..... 440
Specialty Probes ..... 441
Current Probes ..... 442
Accessories/Adaptors ..... 446

## A PROBE FOR VIRTUALLY EVERY APPLICATION

Usually there are several probes from which to select. We've indicated in this guide those probes which offer the best performance match, along with other compatible combinations.

| | Passive | | | | | | | | | | | | | | | | | | | | Active | | | Differ-ential | | | High Voltage | | | Specialty | | | | Current | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P6006 | P6008*3 | P6028 | P6048 | P6053B | P6056 | P6057 | P6060 | P6062B | P6063B | P6101A | P6102A | P6105A | P6106A | P6107A | P6108A | P6121 | P6122 | P6130 | P6131 | P6149A | P6201 | P6202A | P6230 | P6055*4 | P6046 | A6902B | P6007 | P6009 | P6015 | 40 kV | P6420 | P6430 | P6601 | P6602 | P6021*1 | P6021*2 | P6022*1 | P6022*2 | A6302*5 | A6303*5 |
| **7000 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **7A13** | – | – | – | | + | | | – | + | – | – | | ✓ | + | – | – | | – | + | | – | + | + | + | ✓ | – | – | – | + | – | | | | | | – | – | + | – | – | – |
| **7A15A** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **7A16A** | – | – | – | – | – | | | – | – | – | – | | – | ✓ | – | – | | – | + | | – | + | + | + | – | – | – | – | – | – | | | | | | – | – | – | – | – | – |
| **7A18A** | – | + | – | + | + | | | – | + | + | – | | ✓ | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | + | | | | | | – | – | + | – | – | – |
| **7A19** | | | | | | + | + | | | | | | | | | | | | | | | + | – | + | | – | – | | | | | | | | | | – | | – | – | – |
| **7A22** | + | + | + | | | | | + | + | + | + | + | | | + | | | | | + | + | + | + | ✓ | + | + | + | + | | | | | | | | + | + | + | + | + | + |
| **7A24** | | | | | | + | + | | | | | | | | | | | | | | | + | + | | | – | – | | | | | | | | | | – | | – | – | – |
| **7A26** | – | – | – | – | + | | | – | – | ✓ | – | – | ✓ | – | – | | – | + | | – | + | + | + | – | – | – | – | – | – | | | | | | – | – | + | – | – | – |
| **7A29** | | | | | | + | + | | | | | | | | | | | | | | | – | – | + | | – | – | | | | | | | | | | – | | – | – | – |
| **7A42** | – | – | – | | – | + | + | – | – | – | – | | – | – | – | – | | – | – | ✓ | | + | + | ✓ | | | – | – | – | – | | | | | ✓ | – | – | – | – | – | – |
| **7D12** | + | + | – | + | + | | | + | + | + | + | | + | + | + | + | | + | + | | + | + | + | + | ✓ | + | – | + | + | + | | | | | | + | + | + | + | + | – |
| **7D13A** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ✓ | ✓ | | ✓ | | | | | | | |
| **7D20** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | + | + | | – | + | + | + | – | + | | – | + | + | | | | | | – | – | – | – | – | |
| **5000 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **5A13N** | + | + | + | | | | | + | + | | + | + | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **5A14N** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **5A15N** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **5A18N** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **5A21N** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | ✓ | + | + | + | + | + | | | | | | ✓ | + | + | + | + | + |
| **5A22N** | + | + | + | | | | | + | + | | + | + | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **5A26** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | ✓ | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **5A38** | + | + | – | + | + | | | + | + | + | – | | ✓ | + | + | + | | + | + | | + | + | + | + | + | + | – | – | + | + | | | | | | + | + | + | + | + | – |
| **5A45** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | + | + | | – | + | + | + | + | + | – | – | + | + | | | | | | + | – | + | + | – | – |
| **5A48** | – | + | – | + | + | | | – | + | + | – | | ✓ | + | + | + | | + | + | | + | + | + | + | + | + | – | – | + | + | | | | | | + | – | + | + | + | – |
| **5D10** | + | + | + | | | | | + | + | | – | | | | + | | | | | + | + | + | + | + | + | + | – | + | + | | | | | | + | + | + | + | + | + |
| **TM 500 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **AM 502** | + | + | + | | | | | + | + | | + | | | | + | | | | | + | + | + | + | ✓ | + | + | + | + | + | | | | | | ✓ | + | + | + | + | + |
| **AM 503** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ✓ | ✓ |
| **DM 501A** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ✓ | | + | | | | | | | |
| **DM 502A** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ✓ | | + | | | | | | | |
| **DM 505** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ✓ | | + | | | | | | | |
| **SC 501** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | + | | + | + | + | + | | + |
| **SC 502** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **SC 503** | + | + | + | | | | | + | + | | + | ✓ | | | + | | | | | + | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **SC 504** | – | + | – | + | + | | | – | + | + | – | | + | | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **TM5000 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **DC 5009** | – | – | – | | | | | – | – | | – | | – | | – | – | | – | + | | – | + | + | + | – | – | – | – | – | – | | | | | | – | – | + | – | – | – |
| **DC 5010** | – | – | – | – | – | + | + | – | – | – | – | | – | | – | – | | – | – | | – | + | + | + | – | – | – | – | – | – | | | | | | – | – | – | – | – | – |
| **DM 5010** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ✓ | + | | | | | | | | | | |
| **SI 5010** | | | | | | + | + | | | | | | | | | | | | | | | + | + | + | | – | – | | | | | | | | | | – | | – | – | – |

✓ Indicates recommended combinations of probe and instrument.
\+ Indicates usable combinations where probe bandwidth exceeds that of instrument.
– Indicates combinations where probe limits system bandwidth.

*1 With Termination
*2 With 134 Amplifier
*3 Environmental Probe
*4 Matched pair 015-0437-00
*5 With AM 503

## THE ABCs OF PROBES

This comprehensive booklet on signal acquisiton probes contains sections on understanding probe specifications and applications and sections on how to select the best probe for your application. Easy to use charts and tables speed the selection process.

For your free copy, ask your Tektronix Sales Engineer for Literature *60W-6053* or call toll-free in the USA 1-800-426-2200. In Oregon, call collect (503) 627-9000.

| | Passive | | | | | | | | | | | | | | | | | | | | Active | | | Differential | | | High Voltage | | | | Specialty | | | | Current | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P6006 | P6008*3 | P6028 | P6048 | P6053B | P6056 | P6057 | P6060 | P6062B | P6063B | P6101A | P6102A | P6105A | P6106A | P6107A | P6108A | P6121 | P6122 | P6130 | P6131 | P6149A | P6201 | P6202A | P6230 | P6055*4 | P6046 | A6902B | P6007 | P6009 | P6015 | 40 kV | P6420 | P6430 | P6601 | P6602 | P6021*1 | P6021*2 | P6022*1 | P6022*2 | A6302*5 | A6303*5 |
| **T900 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **T912** | ✓ | + | + | | | | | + | + | | + | | + | | + | + | | + | + | | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **T921** | ✓ | + | + | | | | | + | + | | + | | + | | + | + | | + | + | | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **T922R** | ✓ | + | + | | | + | + | | + | + | + | | + | | + | | | + | | | + | | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| **T932A** | ✓ | + | – | | | | | + | + | | – | | + | | + | ✓ | | + | + | | + | + | + | + | + | – | – | + | + | | | | | | + | + | + | + | + | – |
| **T935A** | ✓ | + | – | | | | | + | + | | – | | + | | + | ✓ | | + | + | | + | + | + | + | + | – | – | + | + | | | | | | + | + | + | + | + | – |
| **300 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **305** | + | + | + | | | | | + | + | | + | + | | | + | | | | | ✓ | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **314** | + | + | + | | | | | + | + | | + | + | | | + | | | | | ✓ | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **323** | + | + | + | | | | | + | + | | + | | + | | + | | | | + | | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **326** | + | + | + | | | | | + | + | | + | + | + | | + | + | | | + | | + | + | + | + | + | + | + | + | + | | | | | | + | + | + | + | + | + |
| **335** | + | + | – | + | + | | | + | + | + | – | | + | + | + | + | | + | + | ✓ | + | + | + | + | + | – | – | + | + | | | – | | | + | + | + | + | + | – |
| **336** | + | + | + | | | | | + | + | | + | | + | | + | + | | + | + | | + | + | + | + | + | + | + | + | + | | | – | | | + | + | + | + | + | + |
| **390AD D** | + | + | – | + | + | | | + | + | + | + | | | + | + | | | + | + | | + | + | ✓ | + | + | – | – | + | + | | | – | | | + | + | + | + | + | – |
| **390AD S** | – | + | – | + | + | | | – | + | + | – | | | + | + | | | + | + | | – | + | + | + | + | – | – | + | + | | | – | | | + | – | + | + | – | – |
| **400 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **434** | + | + | – | + | + | | | + | + | + | + | | ✓ | + | + | + | | + | + | | + | + | + | + | + | + | – | + | + | + | | | | – | | + | + | + | + | + | – |
| **455** | – | + | – | + | + | | | – | + | + | + | | ✓ | + | + | + | | + | + | | + | + | + | + | + | + | – | – | + | + | | | | – | | + | – | + | + | + | – |
| **464** | – | + | – | + | + | | | – | ✓ | + | – | | ✓ | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | – | | – | – | + | – | – | – |
| **465** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | – | | – | – | + | – | – | – |
| **465B** | – | + | – | + | + | | | – | + | + | – | | ✓ | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | – | | – | – | + | – | – | – |
| **465M** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | – | | – | – | + | – | – | – |
| **466** | – | + | – | + | + | | | – | ✓ | + | – | | ✓ | + | + | + | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | – | | – | – | + | – | – | – |
| **475** | – | – | – | – | + | | | – | – | + | – | | – | ✓ | – | – | | – | + | | – | + | + | + | – | – | – | – | – | – | | | | – | | – | – | + | – | – | – |
| **475A** | – | – | – | – | – | | | – | – | – | – | | – | ✓ | – | – | | – | + | | – | + | + | + | – | – | – | – | – | – | | | | – | | – | – | – | – | – | – |
| **485** | – | – | – | – | – | + | + | – | – | – | – | | – | ✓ | – | – | | – | ✓ | | – | + | + | + | – | – | – | – | – | – | | | | – | | – | – | – | – | – | – |
| **2400 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **2430** | – | – | – | – | – | + | + | – | – | – | – | | – | – | – | – | | – | – | ✓ | | + | + | + | | – | – | – | – | – | | | | – | | – | – | – | – | – | – |
| **2445** | – | – | – | + | + | + | + | – | – | + | – | | – | + | – | – | | – | + | ✓ | | + | + | + | | – | – | – | – | – | | | | – | | – | – | + | – | – | – |
| **2465** | – | – | – | – | – | + | + | – | – | – | – | | – | – | – | – | | – | – | ✓ | | + | + | + | | – | – | – | – | – | | | | – | | – | – | – | – | – | – |
| **2200 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **2213A** | – | + | – | | | | | – | + | | – | | + | | + | + | | ✓ | + | | – | + | + | + | + | + | – | – | + | + | | | | | | + | – | + | + | – | – |
| **2215A** | – | + | – | | | | | – | + | | – | | + | | + | + | | ✓ | + | | – | + | + | + | + | + | – | – | + | + | | | | | | + | – | + | + | – | – |
| **2220** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | ✓ | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **2230** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | ✓ | + | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **2235** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | | ✓ | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **2236** | – | + | – | + | + | | | – | + | + | – | | + | + | + | + | ✓ | + | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **2300 Series** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **2335** | – | + | – | + | + | | | – | + | + | ✓ | | + | + | + | ✓ | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **2336** | – | + | – | + | + | | | – | + | + | ✓ | | + | + | + | ✓ | | + | + | | – | + | + | + | – | + | – | – | + | – | | | | | | – | – | + | – | – | – |
| **2337** | – | + | – | + | + | | | – | + | + | ✓ | | + | + | + | ✓ | | + | + | | – | + | + | + | – | + | – | – | + | – | ✓ | | | | | – | – | + | – | – | – |

✓ Indicates recommended combinations of probe and instrument.
\+ Indicates usable combinations where probe bandwidth exceeds that of instrument.
– Indicates combinations where probe limits system bandwidth.

*1 With Termination
*2 With 134 Amplifier
*3 Environmental Probe
*4 Matched pair 015-0437-00
*5 With AM 503

**See the Difference**

The photos at right show signals measured with Tek probes and their commodity counterparts. To get the best performance from your measurement system use Tek probes!

## GLOSSARY

**Aberrations** — Deviation from a theoretically correct response to an input signal. Measured in + and − deviation from the final level (flat top).

**A-S Product (Amp Second)** — A figure of merit applied to current probes when operated under pulse-type conditions. When the peak current times the pulse width exceeds the A-S rating, the core will tend to saturate and clip portions of the displayed signal.

**Bandwidth** — Tektronix probe bandwidth specifications assume scope bandwidth "at the probe tip" unless otherwise noted. The specified probe bandwidth must be equal to or greater than the specified scope bandwidth. (All BW figures refer to the −3 db point).

**Compensation Range** — The range of the scope input amplifier input capacitances for which you can compensate your probe.

**Circuit Loading** — A function of total probe impedance at a specific frequency. Probe tip capacitance becomes the major contributor to circuit loading as frequencies increase or risetimes decrease.

**CMRR** (Common-mode Rejection Ratio) — A description of a probe/differential amplifier's ability to reject common-mode signals. At a system CMRR of 10,000:1, a 10 V common-mode input signal will be attenuated to 1 mV at the output, while the differential (desired) signal will be amplified times the system gain.

**Derating** — Passive voltage probes maximum input voltage is derated after some specific upper frequency. Ac current probes upper and lower frequency derating points are specified for maximum continuous currents.

**Dynamic Range** — Applies to Active (FET) probes. Specified as the maximum linear as operating range in volts.

**Insertion Impedance** — Associated with current probes describing the loading effect in ohms (Z) at some specific frequency.

**Maximum Input Voltage** — Maximum allowable input at the probe tip. Specified as dc + peak ac.

**Maximum Ac Current (CW)** — Maximum continuous current handling ability of a current probe. Derated with frequency.

**Maximum Peak Pulse Current** — Maximum peak current handling ability of a current probe. Always greater than the maximum continuous current rating. Controlled by the Amp-Second product.

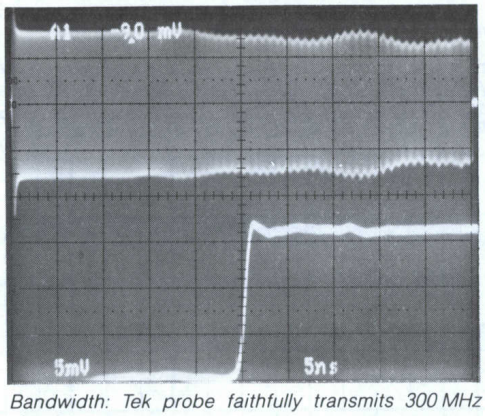
**Maximum Peak Pulse Voltage** — Maximum peak voltage handling ability of high voltage probes. Specification carries pulse width and duty cycle restrictions.

**Risetime** — A probe's 10% to 90% response to a step function.

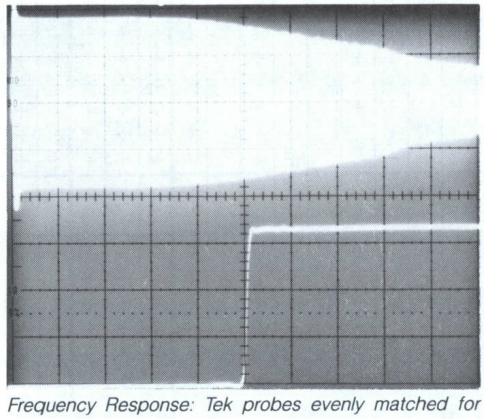
**Ringing** — Damped oscillation response usually caused by inductive effects of poor probe grounding techniques.

**Tangential Noise** — A practical method of specifying probe generated noise (active probes). Tangential noise figures are approximately two times RMS noise.

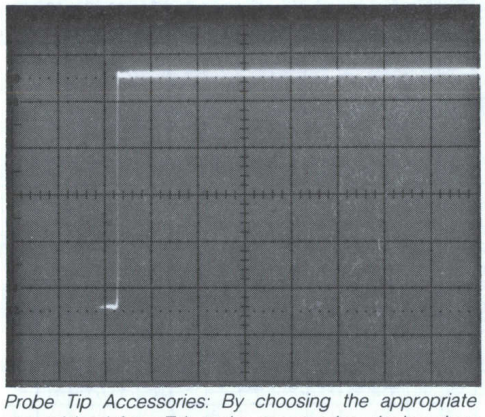
**Optimum Performance With Tek**



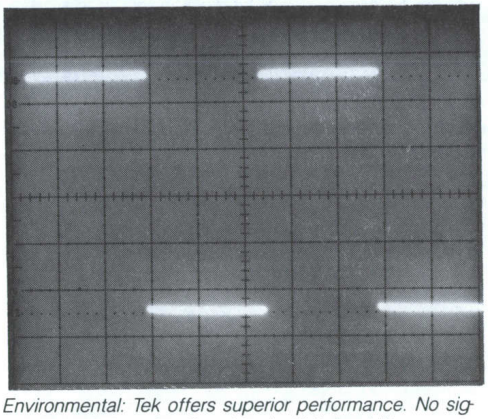

*Bandwidth: Tek probe faithfully transmits 300 MHz signal.*



*Frequency Response: Tek probes evenly matched for clear response.*

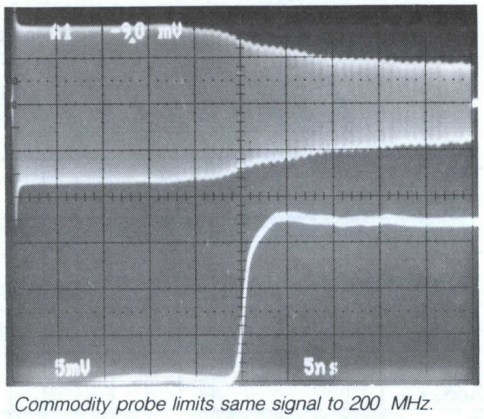


*Probe Tip Accessories: By choosing the appropriate ground lead from Tek probe accessories, ringing does not exist.*

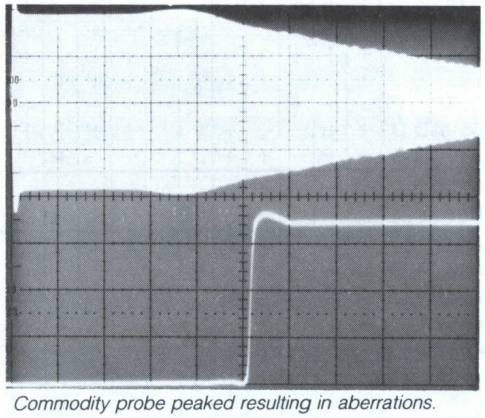


*Environmental: Tek offers superior performance. No signal degradation after five days in high humidity.*

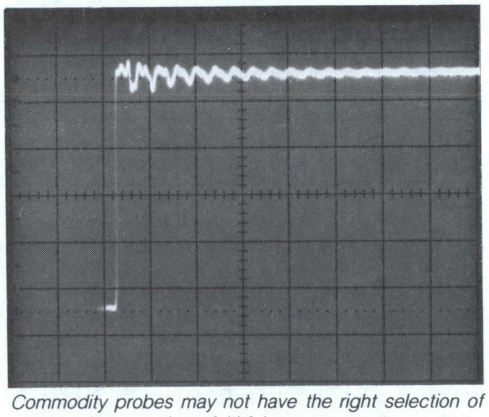
**Loss With Commodity Probe**



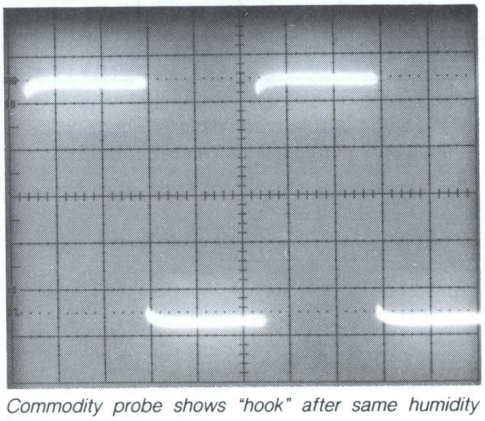

*Commodity probe limits same signal to 200 MHz.*



*Commodity probe peaked resulting in aberrations.*



*Commodity probes may not have the right selection of accessories to make a faithful measurement.*



*Commodity probe shows "hook" after same humidity test.*

## PASSIVE PROBES

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source impedance. For frequencies higher than 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, these probes offer a wide probe selection for a variety of applications for 1 MΩ inputs.

Modular probes are an exciting concept in probe design. The P6101A, P6102A, P6104A, P6105A, P6106A, P6107A, P6108A, P6121, P6122, P6130, P6131, P6148 and P6149A probes divide into three modules (probe heads, cables, and connector/compensation boxes.)

**Quick Delivery**

*NEW* The following probes are now available for shipping within 24 hours:

P6101A 1X Probe, 2m. Order 010-6101-13

P6105A 10X Probe, 2m. Order 010-6105-13

P6106A 10X Probe, 2m. Order 010-6106-13

P6122 10X Probe, 1.5m. Order 010-6122-01

P6131 10X Probe, 1.3m. Order 010-6131-01

See pages 430, 431, 433.

**To order call 1-800-426-2200.**

| TYPE | ATTEN | LENGTH*1 | PACKAGE NUMBER | LOADING | | BW MHz*2*4 at −3 dB | DC MAXIMUM | SCOPE C IN pF | READOUT | PAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| P6006 | 10X | 3.5 ft<br>6 ft<br>9 ft<br>12 ft | 010-0127-00<br>010-0160-00<br>010-0146-00<br>010-0148-00 | 10 MΩ | 7.5 pF*2<br>8.5 pF<br>11.0 pF<br>15.0 pF | 35.0<br>25.0<br>25.0<br>12.0 | 600 V | 15 to 55 | NO | — |
| P6007 | 100X | 3.5 ft<br>6 ft<br>9 ft<br>12 ft | 010-0150-00<br>010-0165-00<br>010-0152-00<br>010-0154-00 | 10 MΩ | 2.0 pF*2<br>2.2 pF<br>2.4 pF<br>2.6 pF | 25.0<br>20.0<br>15.0<br>13.0 | 1.5 kV | 15 to 55 | NO | 440 |
| P6008 | 10X | 3.5 ft | 010-0129-00 | 10 MΩ | 7.5 pF | 100.0 | 600 V | 12 to 47 | NO | — |
| P6008 (Environmentalized) | 10X | 6 ft | 010-0129-01 Environmentalized −50°C to +150°C | 10 MΩ | 7.5 pF | 100.0 | 600 V | 12 to 47 | NO | 441 |
| P6009 | 100X | 9 ft<br>9 ft | 010-0170-00<br>010-0264-01 | 10 MΩ | 2.5 pF<br>2.5 pF | 120.0<br>100.0 | 1.5 kV | 12 to 47 | NO<br>YES | 440 |
| P6010 | 10X | 3.5 ft | Furnished with S-5. For other uses see P6105A or P6106A. | | | | | | | |
| P6015 | 1000X | 10 ft | 010-0172-00 | 100 MΩ | 3.0 pF | 75.0 | 20 kV | 12 to 47 | NO | 440 |
| P6028 | 1X | 3.5 ft<br>6 ft<br>9 ft<br>12 ft | 010-0074-00<br>010-0075-00<br>010-0076-00<br>010-0077-00 | 1 MΩ | 50.0 pF<br>67.0 pF<br>90.0 pF<br>112.0 pF | 17.0<br>10.0<br>7.0<br>4.0 | 600 V | ANY | YES | — |
| P6048 | 10X | 6 ft | 010-0215-00 | 1 kΩ | 1.0 pF | 100.0 | 20 V | 15 to 20 | NO | 431 |
| P6053B | 10X | 3.5 ft<br>6 ft<br>9 ft | 010-6053-11<br>010-6053-13<br>010-6053-15 | 10 MΩ | 9.5 pF<br>12.5 pF<br>13.5 pF | 200.0<br>200.0<br>115.0 | 500 V | 15 to 24 | YES*5 | 432 |
| P6055*3 | 10X | 3.5 ft | 010-6055-01 | 1 MΩ | 10.0 pF | 60.0 | 500 V | 20 to 47 | YES | 439 |
| P6060 | 10X | 3.5 ft<br>6 ft | 010-6060-01<br>010-6060-03 | 10 MΩ | 7.5 pF*2<br>8.5 pF | 35.0<br>25.0 | 500 V | 15 to 55 | YES | — |
| P6062B | 10X or 1X<br>10X or 1X<br>10X or 1X | 3.5 ft<br>6 ft<br>9 ft | 010-6062-11<br>010-6062-13<br>010-6062-15 | 10 MΩ<br>1 MΩ<br>10 MΩ<br>1 MΩ<br>10 MΩ<br>1 MΩ | 13.5 pF<br>100.0 pF<br>14.0 pF<br>105.0 pF<br>17.0 pF<br>135.0 pF | 100.0<br>8.0<br>100.0<br>6.0<br>95.0<br>4.5 | 500 V | 15 to 47 | YES | 432 |
| P6063B | 10X or 1X<br>10X or 1X | 3.5 ft<br>6 ft | 010-6063-11<br>010-6063-13 | 10 MΩ<br>1 MΩ<br>10 MΩ<br>1 MΩ | 11.0 pF<br>80.0 pF<br>14.0 pF<br>105.0 pF | 200.0<br>12.0<br>200.0<br>6.0 | 500 V | 15 to 24 | YES | 432 |
| P6101A | 1X | 1.0 m<br>2.0 m<br>3.0 m | 010-6101-11<br>010-6101-13<br>010-6101-15 | 1 MΩ | 32.0 pF<br>54.0 pF<br>78.0 pF | 34.0<br>15.5<br>8.0 | 500 V | ANY | — | 430 |
| P6102A | 10X | 2.0 m | P6102A | 10 MΩ | 13.2 pF | 60.0 | 500 V | 36 to 55 | YES | 430 |
| P6104A | 10X | 2.0 m | 010-6104-11 | 10 MΩ | 11.2 pF | 100.0 | 500 V | 15 to 35 | YES | |
| P6105A | 10X | 1.0 m<br>2.0 m<br>3.0 m | 010-6105-11<br>010-6105-13<br>010-6105-15 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 100.0<br>100.0<br>90.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | YES | 430 |
| P6106A | 10X | 1.0 m<br>2.0 m<br>3.0 m | 010-6106-11<br>010-6106-13<br>010-6106-15 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 250.0<br>250.0<br>150.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | YES | 430 |
| P6107A | 10X | 2.0 m | 010-6107-13 | 10 MΩ | 13.0 pF | 100.0 | 500 V | 20 to 51 | YES | 430 |
| P6108A | 10X | 1.0 m<br>2.0 m<br>3.0 m | 010-6108-11<br>010-6108-13<br>010-6108-15 | 10 MΩ | 8.7 pF<br>11.2 pF<br>13.2 pF | 100.0<br>100.0<br>90.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | NO | 430 |
| P6121 | 10X | 1.5 m | 010-6121-01 | 10 MΩ | 11.0 pF | 100.0 | 500 V | 20 to 26 | YES | 431 |
| P6122 | 10X | 1.5 m<br>2.0 m<br>3.0 m | 010-6122-01<br>010-6122-03<br>010-6122-05 | 10 MΩ | 11.0 pF<br>12.0 pF<br>14.0 pF | 100.0<br>100.0<br>90.0 | 500 V | 15 to 35 | NO | 431 |
| P6125 | 5X | 1.5 m | 010-6125-11 | 5 MΩ | 20.0 pF | 200.0 | 250 V | 15 to 33 | NO | 361 |
| P6130 | 10X | 1.5 m<br>2.0 m<br>3.0 m | 010-6130-01<br>010-6130-03<br>010-6130-05 | 10 MΩ | 12.7 pF<br>13.2 pF<br>14.5 pF | 250.0<br>250.0<br>150.0 | 500 V | 15 to 35<br>15 to 35<br>15 to 30 | YES | 433 |
| P6131 | 10X | 1.3 m<br>2.0 m<br>3.0 m | 010-6131-01<br>010-6131-03<br>010-6131-05 | 10 MΩ | 10.8 pF<br>13.5 pF<br>14.5 pF | 300.0<br>250.0<br>150.0 | 500 V | 14 to 18 | YES | 433 |
| P6133 | 10X | 1.3 m<br>2.0 m<br>3.0 m | P6133 Opt 01<br>P6133<br>P6133 Opt 03 | 10 Ω | 10.8 pF<br>13.5 pF<br>14.5 pF | 150.0<br>150.0<br>120.0 | 500 V | 13 to 30<br>13 to 30<br>13 to 25 | YES | 433 |
| P6148A | 10X | 2.0 m | 010-6148-13 | 10 MΩ | 13.0 pF | 50.0 | 500 V | | NO | 430 |
| P6149A | 10X | 2.0 m | 010-6149-13 | 10 MΩ | 13.0 pF | 50.0 | 500 V | 20 to 51 | NO | 430 |

*1 *All lengths are nominal and measured electrically for optimum performance.*

*2 *Rating varies with scopes having other than 20 pF inputs.*

*3 *Designed for use with scopes having differential inputs.*

*4 *25 Ω source.*

*5 *Trace identification button.*

**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

# TEK MINIATURE MODULAR PASSIVE PROBES

**P6101A**
**Dc to 34 MHz, 1X**

*NEW* **P6102A**
**Dc to 60 MHz, 10X with Readout**

**P6105A**
**Dc to 100 MHz, 10X with Readout**

**P6106A**
**Dc to 250 MHz, 10X with Readout**

**P6108A**
**Dc to 100 MHz, 10X**

**P6107A**
**Dc to 100 MHz, 10X with Readout**

**P6149A**
**Dc to 50 MHz, 10X**

## For 1 MΩ Input

**Simplified, Faster Maintenance and Repairs**

**High Fidelity Signal Acquisition at Low Cost**

**Available in Three Lengths**

**Rugged for Greater Reliability**

### Hybrid Circuitry For Improved Performance

Modular probes are an exciting new concept in probe design. They divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap or screw together making maintenance and repair less expensive, faster, and easier. Snap-on replacement modules eliminate soldering irons and tools, and modular probes do not have to be sent in to be repaired because spare modules can be ordered and stocked. Strain relief and modular component design make these probes rugged for greater reliability.

The P6102A is a miniature 10X passive probe specially designed to be fully compatible with all scopes employing 1 MΩ 47 pF inputs. These include all 5100 Series amplifier plug-ins, TM 500 Series SC 501, SC 502 and SC 503, and all other scopes having nominal 47 pF inputs.

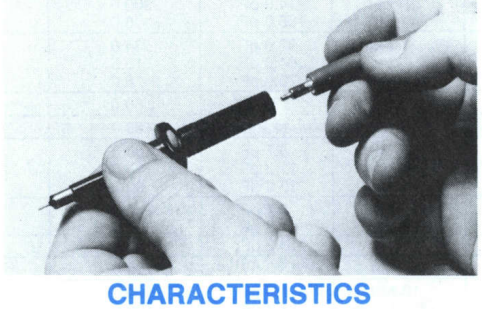
The P6101A, P6102A, P6105A, P6106A, P6107A, P6108A, P6149A probes are used to acquire high fidelity signals from low source-impedance circuits. The P6102A, P6105A, P6106A, and P6107A are designed for oscilloscopes equipped vertical scale or CRT readout. These probes will automatically scale the readout by a factor of ten. The P6149A and P6107A feature a right angle BNC connector.

Tektronix modular probes are designed for specific Tektronix instruments, but may be purchased for all Tektronix oscilloscopes with 1 MΩ and appropriate pF inputs capacitance as indicated in the chart on the preceding page.

For electrical characteristics see the table on the preceding page.

### Compatability Between Previous Versions and Improved Versions

All cables are compatible between the previous and "A" version probes. Compensation boxes and probe heads are not compatible between the two versions due to the hybrid circuitry used in the new probes. A complete reference listing for replacement parts is on page 447.



## CHARACTERISTICS

### ENVIRONMENTAL CHARACTERISTICS

**Temperature —** Operating: −15°C to +75°C (+5°F to +167°F). Nonoperating: −62°C to +85°C (−80°F to +185°F).

**Altitude —** Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

**Humidity —** Operating and Nonoperating: Five cycles (120 hrs) at 95% to 97% relative humidity.

## ORDERING INFORMATION

**P6101A 1X Probe**

**Includes:** Retractable hook tip (BB, 013-0107-05); insulating (BP, 166-0404-01); 130 mm ground lead (DD, 175-0124-01); 300 mm ground lead (DD, 175-0125-01); three pair, black, white and silver gray marker bands, available in packages of nine sets of different colors (016-0633-00); miniature alligator clip (AS, 344-0046-00); accessory pouch (016-0521-00); instruction manual (070-5299-00).

1m Cable. Order 010-6101-11 **$67**
2m Cable. Order 010-6101-13 **$67**
3m Cable. Order 010-6101-15 **$67**

**P6102A 10X Probe**

**Includes:** Same as P6101A except two black marker bands (334-2794-00), two white marker bands (334-2794-01), and two silver-gray marker bands (334-2794-02); plus adjustment tool (003-1364-00); instruction manual (070-5824-00).

2m Cable. Order P6102A **$75**

**P6105A 10X Probe**

**Includes:** Same as P6101A, plus adjustment tool (003-1364-00); instruction manual (070-5516-00).

1m Cable. Order 010-6105-11 **$110**
2m Cable. Order 010-6105-13 **$110**
3m Cable. Order 010-6105-15 **$110**

**P6106A 10X Probe**

**Includes:** Same as P6101A, except 75 mm ground lead (DD, 175-0263-01) instead of 130 mm ground lead, plus adjustment tool (003-1364-00); instruction manual (070-5517-00).

1m Cable. Order 010-6106-11 **$140**
2m Cable. Order 010-6106-13 **$140**
3m Cable. Order 010-6106-15 **$140**

**P6107A 10X Probe**

**Includes:** Same as P6101A without marker band, plus adjustment tool (003-1364-00); instruction manual (070-5518-00).

2m Cable. Order 010-6107-13 **$117**

**P6108A 10X Probe**

**Includes:** Same as P6101A, plus adjustment tool (003-1364-00); instruction manual (070-5519-00).

1m Cable. Order 010-6108-11 **$100**
2m Cable. Order 010-6108-13 **$100**
3m Cable. Order 010-6108-15 **$100**

**P6149A 10X Probe**

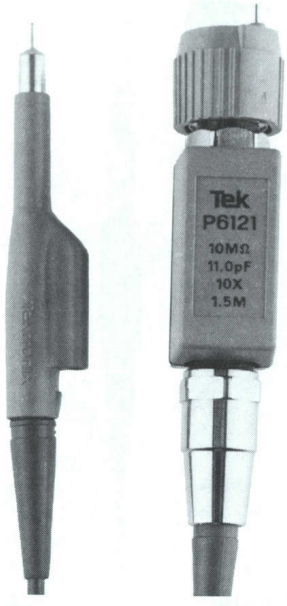
**Includes:** Same as P6102A.
2m Cable plus adjustment tool (003-1364-00); instruction manual (070-5510-00).
Order 010-6149-13 **$110**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## P6121 Dc to 100 MHz, 10X with Readout
## P6122 Dc to 100 MHz, 10X




### For 1 MΩ Input

- Lightweight Tip
- Flex Lightweight Cable
- 100 MHz Bandwidth
- UL Listed

The P6121 and P6122 probes are miniature, 10X passive probes and are fully compatible with the Tektronix family of miniature probe accessories. The P6121 with readout capability is specifically designed for use with the Tektronix 2236 portable oscilloscope to provide close tolerance reading when using the 2236 DMM functions. The P6122 general purpose probe accommodates oscilloscopes with bandwidths up to 100 MHz. These probes feature modular, easily replaceable parts, easy to use configuration, and hybrid circuitry. The hybrid probe tip circuitry proves more uniform probe tip compensation for better high frequency response with reduced aberration and also extremely good environmental characteristics (see Electrical Characteristics table).

### CHARACTERISTICS
### ELECTRICAL CHARACTERISTICS

| | Probe Length | P6121 | P6122 |
|---|---|---|---|
| Attenuation | | 10X ±0.2% | 10X ±3% |
| Loading | 1.5 m | 11 pF/10 MΩ | 11 pF/10 MΩ |
| Bandwidth | 1.5 m | 100 MHz | 100 MHz |
| Dc Max | | 500 V | 500 V |
| Scope Compatibility | | Designed to be used only with the Tektronix 2236. (1 MΩ input) | May be used w/ any Tektronix 100 MHz, 1 MΩ, 15 to 35 pF scope or plug-in*1. |

*1 *Typical applications include the Tektronix T935A, T922R, T921, 2213, 2215, 2235, 2335, 2336, 2337, 5A38, 5A48, 7A15A, and the 7A18A.*

### ENVIRONMENTAL

**Temperature Range** — Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

**Humidity** — Five cycles (120 hrs) 95% to 97% at +30°C to +60°C. MIL-E-16400F, Class 4.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

### ORDERING INFORMATION

**P6121** 10X, Probe
1.5 m Cable. Order 010-6121-01 **$100**

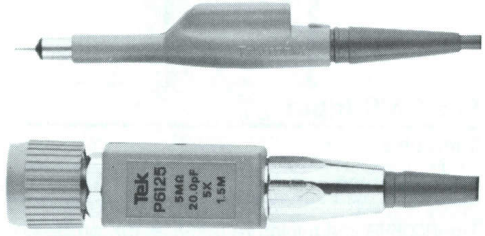
**Includes:** Protective pouch (016-0708-00); retractable hook tip (013-0107-05); ground cover sleeve (166-0404-01) alligator ground lead (195-1870-00); IC test tip (015-02-1-03); bayonet ground lead (195-6176-00); gray marker band (334-2794-02); miniature alligator clip (344-0046-00); instruction sheet (070-5511-00).

**P6122** 10X Probe

**Includes:** Same as P6121 plus instruction sheet (070-5512-00).

1.5 m. Order 010-6122-01 **$77**
2 m. Order 010-6122-03 **$77**
3 m. Order 010-6122-05 **$77**

## P6125 Dc to 250 MHz, 5X




### For 1 MΩ Input

- Counter Probe

The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with dc to 250 MHz digital counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

### CHARACTERISTICS

**Attenuation** — 5X.
**Input Resistance** — 5 MΩ input.
**Capacitance** — ≈20 pF.
**Bandwidth** — Dc to 200 MHz.
**Voltage Rating** — 250 V (dc + peak ac) derated to 35 V at 100 MHz.
**Cable Length** — 1.5 meters.

### ORDERING INFORMATION

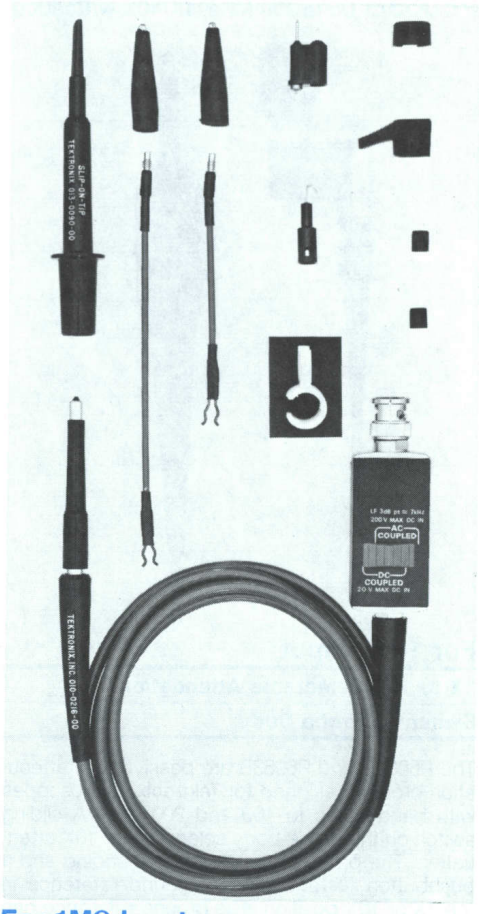
**P6125** 5X, Counter Probe
1.5 m Cable. Order 010-6125-01 **$70**

**Includes:** 8 cm ground lead (175-0263-01); accessory pouch (016-0521-00); two miniature alligator clips (344-0046-00); IC tip tester*1, two 13 cm ground lead probe*2 tips (175-0124-01); retractable hook tip (013-0107-05); probe holder (352-0351-00); insulating sleeve (166-0404-01); instruction sheet (070-3617-00).

*1 *Available in packages of 10 (015-0201-04) or 100 (015-0201-05).*

*2 *Available in packages of 10 only (206-0191-03).*

## P6048 Dc to 100 MHz, 10X




### For 1MΩ Input

- Minimum Loading 1 pF to 1 kΩ
- Ac/dc Switch

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF oscilloscopes. The probe input impedance of 1 kΩ paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. Ac or dc coupling switch is available to extend the measurement range.

### CHARACTERISTICS

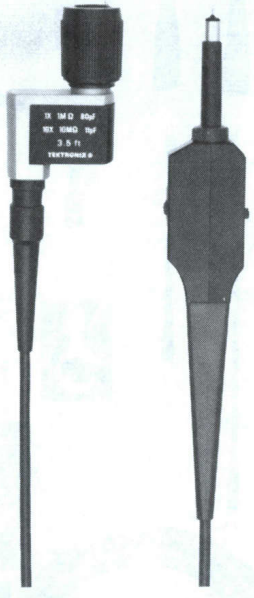
**Attenuation** — 10X.
**Input Resistance** — 1 kΩ.
**Input Capacitance** — 1 pF or less.
**Maximum Input** — Dc 20 V; ac 200 V.
**Ac Low Frequency** — 7 kHz or less.
**Bandwidth** —
100 MHz with 150 MHz bandwidth scope;
175 MHz with 250 MHz bandwidth scope.
**Typical Probe Risetime** — 1.95 ns.

### ORDERING INFORMATION

**P6048** 10X, Probe
6 ft Cable. Order 010-0215-00 **$205**

**Includes:** Bayonet probe tip (BM, 013-0085-00); retractable probe hook tip (CA, 013-0090-00); two electrical insulating sleeves (BP,166-0404-01); two alligator clips (AS, 344-0046-00); 13 cm (5 in) ground lead (175-0124-01); insulating sleeve ground lead (CN, 166-0433-00); probe tip hook (BU, 206-0114-00); 7.5 cm (3 in) ground lead (DD, 175-0263-01); probe holder (352-0090-00); instruction manual (070-0675-01).

## P6062B Dc to 100 MHz, 1X/10X w/Readout
## P6063B Dc to 200 MHz, 1X/10X w/Readout



### For 1 MΩ Input

**1X to 10X Selectable Attenuation**

**Switch on Probe Body**

The P6062B and P6063B are passive dual attenuation probes designed for Tektronix oscilloscopes with bandwidths to 100 and 200 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multitrace display. The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

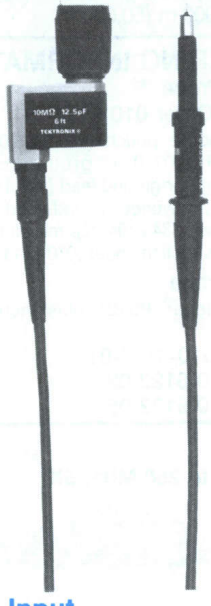
The P6063B is a fast-rise dual attenuation, passive probe designed for Tektronix oscilloscopes with bandwidths greater than 100 MHz.

### CHARACTERISTICS

| | Nominal Probe Length | P6062B | | P6063B | |
|---|---|---|---|---|---|
| Attenuation | | 1X | 10X | 1X | 10X |
| Accuracy | | Same as Scope | 3%*1 | Same as Scope | 3%*1 |
| Input Resistance | | Same as Scope | 10 MΩ*1 | Same as Scope | 10 MΩ*1 |
| Input Capacitance | 3½ ft<br>6 ft<br>9 ft | 100 pF<br>105 pF<br>135 pF | 13.5 pF<br>14 pF<br>17 pF | 80 pF<br>105 pF<br>NA | 11 pF<br>14 pF<br>NA |
| Bandwidth | 3½ ft<br>6 ft<br>9 ft | 8 MHz<br>6.7 MHz<br>4.5 MHz | 100 MHz<br>100 MHz<br>100 MHz | 12 MHz<br>6 MHz<br>NA | 200 MHz<br>200 MHz<br>NA |
| Maximum Voltage | | 100 V peak | 500 V peak | 100 V | 500 V |
| Derated Above | | 450 kHz | 3.5 MHz | 450 kHz | 4.5 MHz |
| Derated to Frequency | | 35 V @ 10 MHz | 35 V @ 50 MHz | 35 V @ 10 MHz | 30 V @ 50 MHz |
| Aberrations | | ±3% | <5% p-p | ±3% | <5% p-p |
| Risetime | | | 3.5 ns | | 1.7 ns |
| Compensation Range | | 15 pF to 47 pF | | 15 pF to 24 pF | |

*1 *In 10X position the input R = 10 MΩ ±0.5% with an oscilloscope input R = 1 MΩ ±2%.*

## P6053B Dc to 200 MHz, 10X with Readout/Trace Identify Functions



### For 1 MΩ Input

**Miniature**

**Fast Risetime**

The P6053B is a miniature fast-rise 10X probe designed for Tektronix instruments having a nominal input capacitance of 15 pF to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

### CHARACTERISTICS

**Attenuation —** 10X.
**Input Resistance —** 10 MΩ.
**Input Capacitance —** 9.5 pF with 3.5 ft probe. 12.5 pF with 6 ft version, 13.5 pF with 9 ft version.
**Bandwidth (with 225 MHz or Greater Oscilloscope) —** ≈200 MHz for 3.5 and 6 ft versions, ≈115 MHz for the 9 ft version.
**Voltage Rating —** 500 V (dc +peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz; 18 V at 150 MHz.

### ORDERING INFORMATION

**P6062B** Switchable Attenuation Probe
**Includes:** Probe holder (352-0351-00); electrical insulating sleeve (BP, 166-0404-01); retractable hook tip (BB, 013-0107-05); probe tip hook (BU, 206-0114-00); accessory pouch (016-0521-00); 13 cm (5 in) ground lead (175-0124-01); 30 cm (12 in) gound lead (DD, 175-0125-01); two alligator clips (AS, 344-0046-00); instruction sheet (062-2927-00).

| | |
|---|---|
| 6 ft. Order 010-6062-13 | $175 |
| 3.5 ft. Order 010-6062-11 | $175 |
| 9 ft. Order 010-6062-15 | $175 |

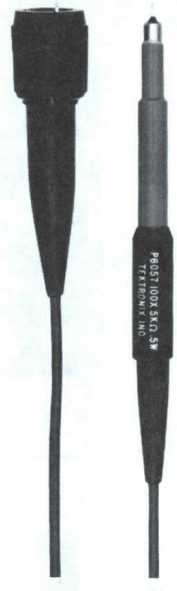
**P6063B** Switchable Attenuation Probe
**Includes:** Same as P6062B, plus instruction sheet (062-2928-01)

| | |
|---|---|
| 6 ft. Order 010-6063-13 | $215 |
| 3.5 ft. Order 010-6063-11 | $215 |

**P6053B** Miniature 10X Probe
**Includes:** Same as P6062B plus bayonet ground assembly (BM, 013-0085-00); 7.5 cm (3 inch) ground lead (DD, 175-0263-01); instruction sheet (070-1594-00).

| | |
|---|---|
| 6 ft. Order 010-6053-13 | $170 |
| 3.5 ft. Order 010-6053-11 | $170 |
| 9 ft. Order 010-6053-15 | $170 |

## P6056 Dc to 3.5 GHz, 10X 500 Ω
## P6057 Dc to 1.4 GHz, 100X 5000 Ω



### For 50 Ω Input

**Low Capacitive Loading, 1 pF or Less**

**<70 ps Probe to Probe Variation**

The P6056 and P6057 are miniature low-capacitance probes for use with 50 Ω wide-band oscilloscopes. Bandwidth is dc to 3.5 GHz. This probe can also be used with 50 Ω sampling systems, with an appropriate BNC adaptor. The P6056 is equipped with a special BNC connector that provides trace identification and CRT readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

### CHARACTERISTICS

| | P6056 | P6057 |
|---|---|---|
| Risetime | <100 ps | <250 ps |
| Input R @ Dc | 500 Ω | 5 kΩ |
| Input R @ 1 GHz | 300 Ω | 1500 Ω |
| Maximum Dc + Peak Ac | 16 V | 50 V |
| Derated Above | 800 MHz | 500 MHz |
| Maximum Peak @ 1 GHz | 9 V | 21 V |
| Maximum Peak Pulse | 500 V <1 ms | 500 V <1 ms |

### ORDERING INFORMATION

**P6056** 10X, 50 Ω Probe
**Includes:** Alligator clip (AS, 344-0046-00); 75 mm (3 in) ground lead (DA, 195-6176-00); hook probe tip (BU, 206-0114-00); probe bayonet tip (BM, 013-0085-00); electrical contact (BQ, 214-0283-00); instruction sheet (070-1224-00).

| | |
|---|---|
| 6 ft. Order 010-6056-03 | $185 |
| 9 ft. Order 010-6056-05 | $185 |

**P6057** 100X, 50 Ω Probe
**Includes:** Same as P6056.

| | |
|---|---|
| 6 ft. Order 010-6057-03 | $190 |
| 9 ft. Order 010-6057-05 | $190 |

**Included Accessories with double alpha codes are pictured on pages 448 and 449.**



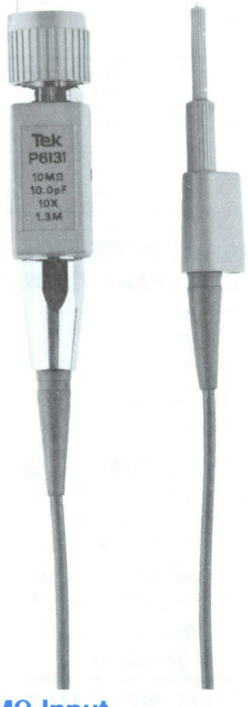
To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

NEW

## P6130
**Dc to 250 MHz, 10X with Readout**

## P6131
**Dc to 300 MHz, 10X with Readout**

## *NEW* P6133
**Dc to 150 MHz, 10X with Readout**




**For 1 MΩ Input**

**Lightweight Tip**

**Flex Lightweight Cable**

**250 MHz Bandwidth**

**UL Listed**

The P6130, P6131 and P6133 are 10X subminiature passive probes. These probes have a spring-loaded coding pin on the BNC output connector which activates the volts/division readout-encoding circuit of the oscilloscope to include the 10X attenuation of the probe.

The P6130 general purpose probe accommodates scopes with bandwidths up to 250 MHz. Choose 1.5 meter, 2 meter, or 3 meter lengths. *The P6131 is specifically designed to be used only with the Tektronix 2465 and the 7A42.* 1.3 meter, 2 meter, and 3 meter lengths are available. *The P6133 is specifically designed for use with the Tektronix 2445.*

These probes feature small size, a low-mass probe tip, and an extremely flexible probe cable. The unique reversible ground lead system provides versatile grounding methods. The hybrid probe tip circuitry provides a rugged lightweight tip, more uniform probe tip compensation for better high frequency response with reduced aberrations, and extremely good environmental characteristics. The modular construction allows easy repair without tools for lower cost of ownership.

A subminiature-to-miniature probe tip adaptor (013-0202-00) is also available. It allows the subminiature probe family to use the wide variety of probe accessories that Tektronix already provides for its miniature probe product line.

## CHARACTERISTICS

### ELECTRICAL

| | Probe Length | P6130 | P6131 | P6133 |
|---|---|---|---|---|
| **Attenuation** | | 10X ±3% | 10X ±1% | 10X ± 1% |
| **Loading** | 1.3 m | — | 10.8 pF/10 MΩ | 10.8 pF/10 MΩ |
| | 1.5 m | 12.7 pF/10 MΩ | — | — |
| | 2.0 m | 13.2 pF/10 MΩ | 13.5 pF/10 MΩ | 13.5 pF/10 MΩ |
| | 3.0 m | 14.5 pF/10 MΩ | 14.5 pF/10 MΩ | — |
| **Bandwidth** | 1.3 m | — | 300 MHz | 150 MHz |
| | 1.5 m | 250 MHz | — | — |
| | 2.0 m | 250 MHz | — | 150 MHz |
| | 3.0 m | 150 MHz | 150 MHz | 120 MHz |
| **Dc Max** | | 500 V | 500 V | 500 V |
| **Scope Compatibility** | | May be used with Tektronix 2235, 2236, 464, 465, 466, 475, 485 and any 7000 Series 1 MΩ plug-in such as 7A15, 7A16, 7A18 and 7A26. | Designed to be use with the Tektronix 2465 and the 7A42. (1 MΩ input) | Designed for use with the Tektronix 2445 |

### ENVIRONMENTAL

**Temperature Range —** Operating: −15°C to +75°C. Nonoperating: −62°C to +85°C.

**Humidity —** Five cycles (120 hrs) 95% to 97% at +30°C to +60°C. MIL-E-16400F, Class 4.

**Altitude —** Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

## ORDERING INFORMATION

**P6130** Subminiature 10X Probe

**Includes:** Alligator ground lead (195-1870-00), microhook ground lead (195-4104-00); low inductance ground lead (195-4240-00); white marker band (334-2794-01); gray marker band (334-2794-03); red marker band (334-2794-06); green marker band (334-2794-07); probe connector (131-2766-03); probe holder (352-0687-00); protective pouch (016-0708-00); retractable hook tip (013-0208-00); instruction sheet (070-5513-00).

1.5 m Cable. Order 010-6130-01 **$130**
2 m Cable. Order 010-6130-03 **$130**
3 m Cable. Order 010-6130-05 **$130**

**P6131** Subminiature 10X Probe

**Includes:** Same as P6130, except instruction sheet (070-5514-00).

1.3 m Cable. Order 010-6131-01 **$140**
2 m. Order 010-6131-03 **$140**
3 m. Order 010-6131-05 **$140**

**P6133** Subminiature 10X 2m Probe

**Includes:** Alligator ground lead (195-1870-00); retractable hook tip (013-0208-00); probe connector with socket; probe adjustment tool (003-1364-00); probe connector (131-2766-03); instruction sheet.

**Option 01*[1]** — 1.3 m length
**Option 03*[1]** — 3.0 m length

*[1] *Contact your local sales office.*

*P6130 shown with 013-0202-00 adaptor in place.*

### SUBMINIATURE PROBE ACCESSORIES

KLIPKIT 013-0197-00 | SIGNAL/GROUND PINS 013-3288-02 | PROBE-TO-BNC 013-0195-00

**KLIPKIT –** Provides hands-free connection to integrated circuits. The P6130, P6131 and P6230 are used directly, other probes must use the supplied pins and attach via a retractable hook tip. Up to 16 pin DIP may be connected. Four supplied pins make signals accessible at the top of the KLIPKIT, or invert the pins for pin signal connection to a common connection strap inside the clip. (Particularly useful when common ground connection is desired).

**Includes:** Two IC clips, 4 signal ground pins and information sheet. Order 013-0197-00 **$40**

**Signal/Ground Pins —** Packets of four. Order 131-3288-02 **$25**

**Probe to BNC Adaptor** — Order 013-0195-00 **$9.00**

PROBE-TO-GR 017-0520-00 | TEST POINT 131-2766-01 136-0352-02 | SUBMINIATURE 013-0202-00

**50 Ω Probe to GR Adaptor —** Order 017-0520-00 **$48**

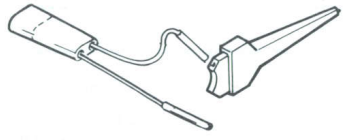
**100 ECB Test Connectors —** Outer Shell. Order 131-2766-01 **$37**

**100 Probe ECB Test Connectors —** Center. Order 136-0352-02 **$19.25**

**Subminiature-to-Miniature Adaptor —** Order 013-0202-00 **$4.00**

### MINIATURE PROBE ACCESSORIES

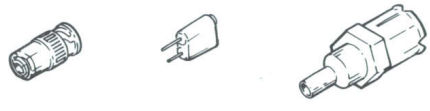
MINIATURE PROBE TIP TO DUAL LEAD ADAPTOR 015-0325-00 | MINIATURE RETRACTABLE HOOK TIP 206-0222-00



**Miniature Probe Tip-to-Dual Lead Adaptor —** Order 015-0325-00 **$15**

**Microcircuit Pincer Tip —** Order 206-0222-00 **$3.50**

PROBE TO BNC 013-0084-01 | BAYONET 013-0085-00 | PROBE-TO-GR 017-0088-00



**Miniature Probe-to-BNC Adaptor —** Order 013-0084-01 **$8.00**

**Miniature Bayonet Tip Adaptor —** Order 013-0085-00 **$8.50**

**50 Ω Miniature-to-GR Adaptor —** Order 017-0088-00 **$50**

Active probes have high input resistance and low input capacitance without loss of signal. The dynamic range and measurement capability are substantially increased through the voltage offset control.

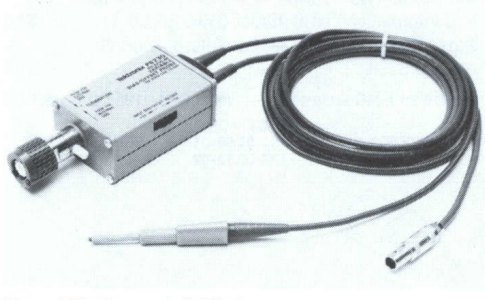
Since active probes have a selectable 50 Ω output impedance, the distance from the probe tip to the instrument is only limited by the bandwidth limit of the 50 Ω coaxial cables between the probe and instrument. Active probes are used in measurements where high input resistance and low input capacitance is needed and where frequencies above 250 MHz are encountered.

**ACTIVE PROBES SELECTION GUIDE**

| Type | Attn | Nominal Length | Loading | | Risetime | Input Limits: Maximum Dc + Pk Ac | Input Limits: Linear Dynamic Range | Input Limits: Dc Offset Range | Read-Out | Page | Prices |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P6046 Diff/Amp | 1X<br>10X | 6 ft | 1 MΩ<br>10 MΩ | 10 pF<br>3 pF | 3.5 ns | ±25 V<br>±250 V | ±5 V<br>±50 V | | NO | 439 | $1,750 |
| P6201 FET | 1X<br>10X<br>100X | 6 ft | 100 kΩ<br>1 MΩ<br>1 MΩ | 3 pF<br>1.5 pF<br>1.5 pF | 0.4 ns | ±100 V<br>±200 V<br>±200 V | ±0.6 V<br>±6 V<br>±60 V | ±5.6 V<br>±56 V<br>±200 V | YES | 435 | $1,220 |
| P6202A FET | 10X<br>100X | 2 m | 10 MΩ<br>10 MΩ | 2 pF<br>2 pF | 0.7 ns<br>0.7 ns | ±200 V<br>±200 V | ±6 V<br>±60 V | ±55 V<br>±200 V | YES<br>NO | 435 | $680 |
| P6230 Bias/Offset | 10X | 1.5 m | 450 Ω | 1.3 pF | 230 ps | ±30 V | ±5 V | ±5 V | YES | 434 | $395 |

## P6230

### Dc to 1.5 GHz, 10X Bias/Offset



### For 50 Ω or 1 MΩ Inputs

**Bias/Offset from −5 V to +5 V**

**Internal/External 50 Ω Termination Switch—Use on Scopes with 50 Ω or 1 MΩ Input**

**Low Impedance**

**Adjustable Tip "Nulling" Voltage**

**Fully Compatible with Tek Subminiature Probe Accessories**

**UL Listed**

The P6230 is a 1.5 GHz, low-impedance, subminiature, 10X active probe for use with broad-band oscilloscopes. The P6230 is equipped with an internal/external 50 Ω termination switch which allows the probe to be used on scopes having an input resistance of either 50 Ω or 1 MΩ. A coding pin on the BNC connector activates the Volts/Division reading by 10X, on oscilloscopes equipped with this feature, so that the correct deflection factor at the probe tip is indicated.

The compensation box houses an active circuit which provides a variable voltage at the probe tip. This voltage is used to minimize probe-loading effects. The voltage available at the tip spans the range from minus five volts to plus five volts, allowing the probe to minimize loading effects on most logic families that are in use today.

The P6230 acts as a standard 500 Ω passive voltage probe with the additional capability of having an adjustable tip "nulling voltage." This feature reduces the dc-loading effects of the probe when it is used to measure signals whose mid-voltage value is other than zero volts, or in circuits where the termination impedance is returned to other than ground level. The Input Bias/Offset Voltage may be adjusted so that at a particular test-signal voltage both ends of the probe input-resistor are at equal potentials and no current is flowing through the resistor.

ECL logic is most commonly operated from a −5.2 V supply with Vcc connected to ground. The output of an ECL gate is the emitter of an NPN emitter follower stage. The output is pulled down to a negative supply (about −2 V) with an external resistor (50 Ω to 100 Ω). Since speed is a major consideration in ECL designs, the interconnections between gates are often transmission lines, and the pull-down resistor doubles as a line termination.

If a standard 500 Ω, 10X probe without the Input Bias/Offset feature were used to examine an ECL output, the probe's 500 Ω resistance to ground would form a voltage divider with the gate's output-termination resistor. This divider can cause distortion of the output signal levels, shift the dc-operation point of the output transistor, and reduce the gate's noise margin.

The dc-load nulling capability of the P6230 helps to solve this problem. By adjusting the Input Bias/Offset Voltage to the ECL low level or to the termination voltage, the only effect of the probe resistance will be a small decrease in the ECL output-termination resistance. The effect of the probe on output voltage levels is negligible.

The probe derives its power from the probe power jack on many Tek scopes, a 1101 or 1101A Power Supply (see next page).

## CHARACTERISTICS

### ELECTRICAL CHARACTERISTICS

**Attenuation** — 10X ±3%.

**Loading** — 1.3 pF/450 Ω.

**Bandwidth** — 1.5 GHz.

**Dc Offset Range** — −5 V to +5 V.

**Dc Maximum** — 10 V.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C (+32°F to +122°F). Nonoperating: −55°C to +75°C (−67°F to +167°F).

**Humidity** — Five cycles (120 hrs) 95% to 97% at 30°C to 60°C. MIL-E-16400F, Class 4.

**Altitude** — Operating: 4600 m (15,000 ft). Nonoperating: 15 000 m (50,000 ft).

## ORDERING INFORMATION

**P6230** 10X, Bias/Offset Probe
1.6 m Cable. Order 010-6230-01 **$395**

**Includes:** Alligator ground lead (195-1870-00); microhook ground lead (195-4104-00); low inductance ground lead (195-4240-00); two white marker bands (334-2794-01); two gray marker bands (334-2794-03); protective pouch (016-0708-00); retractable hook tip (013-0208-00); two red marker bands (334-2794-06); two green marker bands (334-2794-07); probe connector (131-2766-03); probe holder (352-0687-00); instruction manual (070-4211-00).

### OPTIONAL ACCESSORIES

**Probe to BNC Adaptor** — Order 013-0195-00 **$9.00**

**50 Ω Probe to GR Adaptor** —
Order 017-0520-00 **$48**

**100 ECB Test Connectors** — Outer Shell.
Order 131-2766-01 **$37**

**100 ECB Test Connectors** — Center.
Order 136-0352-02 **$19.25**

**Subminiature to Miniature Adaptor** —
Order 013-0202-00 **$4.00**

**THE FOLLOWING ARE USED WITH 013-0202-00**

**Miniature to BNC Adaptor** —
Order 013-0084-01 **$8.00**

**50 Ω Miniature to GR Adaptor** —
Order 017-0088-00 **$50**

**Miniature to Square Pin Adaptor** —
Order 015-0325-00 **$15**

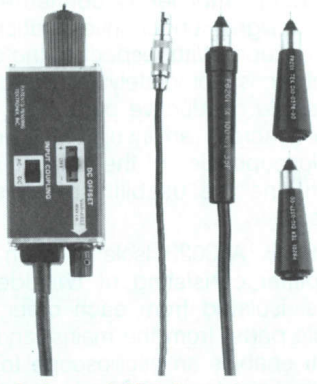
**Microcircuit Pincer Tip** —
Order 206-0222-00 **$3.50**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## P6201 Dc to 900 MHz, 1X



### For 50 Ω or 1 MΩ Inputs

**Unity Gain, Low Input Capacitance**

**Two Plug-on Attenuator Heads that Maintain Scope Readout Factor**

**Dc Offset, Ac-Dc Coupling Switch**

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The probe derives its power from the probe power jack on many Tek scopes, a 1101 or 1101A Power Supply.

### CHARACTERISTICS

| | P6201 | P6202A |
|---|---|---|
| Risetime | <0.4 ns | <0.7 ns |
| Bandwidth (verified by risetime) | >900 MHz | >500 MHz |
| Attenuation | X1 | X10 |
| Attenuation Accuracy | ±3% | ±4% |
| Input Resistance | 100 kΩ | 10 MΩ |
| Input Capacitance | 3 pF | 2 pF |
| Input R with Attenuator | 1 MΩ | 10 MΩ*1 |
| Input C with Attenuator | 1.5 pF | 2 pF*1 |
| Dynamic Range | ±0.6 V | ±6.0 V |
| Dynamic Range with Attenuator | ±6 V or ±60 V | ±60 V*1 |
| Dc Offset Range | ±5.6 V | ±55 V |
| Noise | 300 μV | 150 μV |
| Maximum Input Probe Only | ±100 V peak | ±200 V peak |
| Derated above | 60 MHz | 2 MHz |
| Derated to—at Frequency | 5 V at 500 MHz | 20 V at 300 MHz |
| Maximum Input with Attenuator | 200 V peak | 200 V peak*1 |
| Derated above | 50 MHz | 150 MHz*1 |
| Derate to—at Frequency | 5 V at 500 MHz | 70 V at 400 MHz*1 |
| Ac Coupling—3 dB Low Frequency | 10 Hz | 16 Hz |

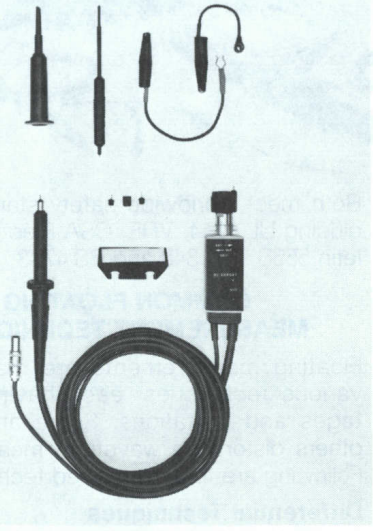
*1 *Optional accessory.*

### ORDERING INFORMATION

**P6201** 1X, FET Probe
6 ft Cable. Order 010-6201-01 **$1,220**

**Includes:** Retractable probe tip (CG, 013-0135-00); 10X attenuator head (010-0376-00); 100X attenuator head (010-0377-00); 3 probe tips (CO, 206-0200-00); probe tip (CJ, 103-0164-00); 30 cm (12 inch) ground lead (DB, 175-0848-02); ground contact (CM, 131-1302-00); alligator clip (AS, 344-0046-00); electrical insulating sleeve (CK, 166-0557-00); ground contact insulator (CL, 342-0180-00); carrying case (016-0156-02); instruction manual (070-1306-00).

## P6202A Dc to 500 MHz, 10X



### For 50 Ω or 1 MΩ Inputs

**Dc Offset, Small Probe Size**

**High Input Impedance through Freq Range**

With its standard Tektronix power connector the P6202A can be used on any instrument that has standard probe power. Low input capacitance permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading. The dc offset feature offsets any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The P6202A derives its power from the probe power jack on many of Tek scopes, a 1101 or 1101A Power Supply.

### ORDERING INFORMATION

**P6202A** 10X, FET Probe **$680**
2 m Cable. Order 010-6202-03

**Includes:** Retractable probe tip (CB, 013-0097-01); two alligator clips (AS, 344-0046-00); probe holder (352-0351-00); 7.5 cm (3 inch) ground (DC, 175-0849-00); probe adjustment tool (CP, 003-0675-01); carrying case (016-0378-00); 13 cm (6 inch) ground lead (DE, 175-1017-00); two replaceable probe tips*1; electrical insulating sleeve (BP, 166-0404-01); instruction manual (070-3642-00).

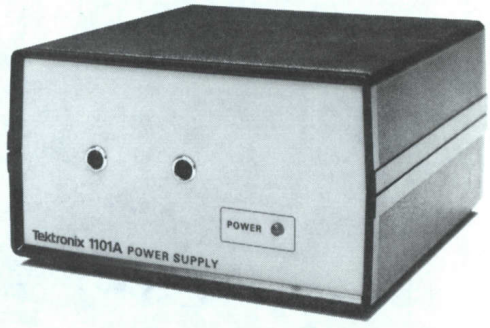
*1 *Available in package of 10 only. Order 206-0230-03 (CF).*

### OPTIONAL ACCESSORIES

**10X Attenuator** — For total 100X attenuation. Order 010-0384-00 **$70**

**Ac Coupling Cap** — Order 010-0360-00 **$34**

## 1101A Power Supply




The 1101A Accessory Power Supply provides power for active probes such as the Tektronix P6201, P6202A and P6230 when they are used with oscilloscopes that do not have a probe power supply.

The 1101A will provide power for up to two probes. Output power features short-circuit protection.

### CHARACTERISTICS

**Output Voltages** — +15 V dc ±2%; −15 V dc ±2%; +5 V dc ±5%.

**Output Currents** — 300 mA each supply (short-circuit protected). +15 V, −15 V supplies: ≤1 mV RMS with 300 mA load.

**Ripple** — +5 V Supply: ≤5 mV RMS with 300 mA load.

**Ac Input Voltages** — Selectable, 87 V ac to 128 V ac or 174 V ac to 250 V ac.

**Line Frequency** — 48 Hz to 440 Hz.

**Power** — 30 W maximum at 115 V ac.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 157 | 6.2 |
| Height | 89 | 3.5 |
| Depth | 165 | 6.5 |
| **Weight** | **kg** | **lb** |
| Net | 1.7 | 3.8 |

### ORDERING INFORMATION

**1101A** Accessory Power Supply **$425**

**Includes:** Instruction sheet 070-5126-00.

**INTERNATIONAL POWER PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.
**Option A2** — UK 240 V/13 A, 50 Hz.
**Option A3** — Australian 240 V/10 A, 50 Hz.
**Option A4** — North American 240 V/15 A, 60 Hz.
**Option A5** — Switzerland 220 V/10 A, 50 Hz.

## ISOLATION ACCESSORIES FOR FLOATING MEASUREMENTS

In the world of oscilloscope use, the ability to make floating measurements is a pressing need.

This often causes users to employ questionable and often unsafe practices to allow the oscilloscope chassis to float at some potential other than ground. Such practices are parts of a larger problem concerning equipment grounding.

"Floating the scope" is the usual technique that is used in such measurements. It is the technique of defeating the protective grounding system—disconnecting the "signal common" from ground—and allowing accessible oscilloscope parts, such as the chassis, enclosure, connectors, and controls to assume the potential of the point at which the ground lead is connected. This is dangerous for two reasons.

First, and most obvious, is the possibly high voltages on exposed metal parts of the oscilloscope that present a shock hazard to the operator.

Second, and not so obvious, is the cumulative stresses on the oscilloscope power transformer insulation. Such stresses can cause future failure, with attendant shock and fire hazard, even after the oscilloscope is returned to properly grounded operation.

From a measurement standpoint the "floated scope" has the problem of imposing a loading effect on the "signal common". This loading is caused by capacitance between the floating scope chassis and the power line which may be considered at ac ground.

The A6901 and A6902B provide the means to make floating measurements without defeating protective grounding systems, and with minimum risk of operator injury, test equipment damage or signal degradation. Both meet worldwide safety standards; including UL 1244, VDE, CSA Electronics Bulletin 556B, IEC 348 and BS 4743.

## COMMON FLOATING MEASUREMENT TECHNIQUES

Floating measurements are made using various techniques, each having advantages and limitations. Some are unsafe, others distort the waveform measurement. Following are three preferred techniques.

### Differential Techniques

The most popular solution for a floating measurement is the A minus B quasi-differential technique. Most general-purpose dual-trace oscilloscopes (such as the Tektronix 2445) have an Add Mode in which the two channels (invert CH 2) can be electrically subtracted, giving a display of the difference signal. This can be a problem when attempting to examine low-level control signals in the presence of high common-mode voltages. Also, the common-mode dynamic range is severely limited (±6 divisions beyond screen height) and CMRR is low—approximately 100:1.

True differential amplifiers are specifically designed to have good rejection of the common-mode signal and display only the difference signal. Because these amplifiers are basically two ground-referenced amplifiers, limited floating or common-mode capability is provided. Further, the ability to display a small signal in the presence of a large common-mode signal changes as a function of the absolute magnitude of the common-mode signal, as well as the ratio of the common-mode signal to the difference signal. Also, there are bandwidth limitations. The Tektronix 7A13 provides 500 volts of common-mode dynamic range at 0.1 V/div with a CMRR of at least 1000:1 and a bandwidth up to 105 MHz.

### Isolation Amplifiers

The isolating amplifier is connected between the signal under investigation and the oscilloscope. With respect to the signal, the amplifier is completely insulated, with no accessible conductive parts. The signal is coupled across an insulating barrier to the oscilloscope. Use of the isolation amplifier maintains the usability of all scope functions.

The Tektronix A6902B Isolator is an isolation amplifier consisting of two identical amplifiers, isolated from each other, from accessible parts, from the mains, and from ground. It enables an oscilloscope to measure potentials from ±20 mV to ±1500 volts. Each signal common lead can be independently connected to separate voltages up to plus or minus 1500 volts. The A6902B can measure two such signals simultaneously, in combination with any dual trace oscilloscope.

### Isolator/Differential Amplifier

Using both A6902B channels as a differential input to a 7A13, 7A22, or A plus B invert scope, provides an extra measure of common-mode performance. To use the isolator as a three-wire probe, the common leads are tied together and not connected to the circuit under test. The signal leads are then used as plus and minus differential inputs. This technique provides the isolator's protection and CMRR, as well as the amplifier's CMRR capabilities, and is particularly useful in circuits where the common-to-ground slew rate is high (i.e., above 50 V/μs).

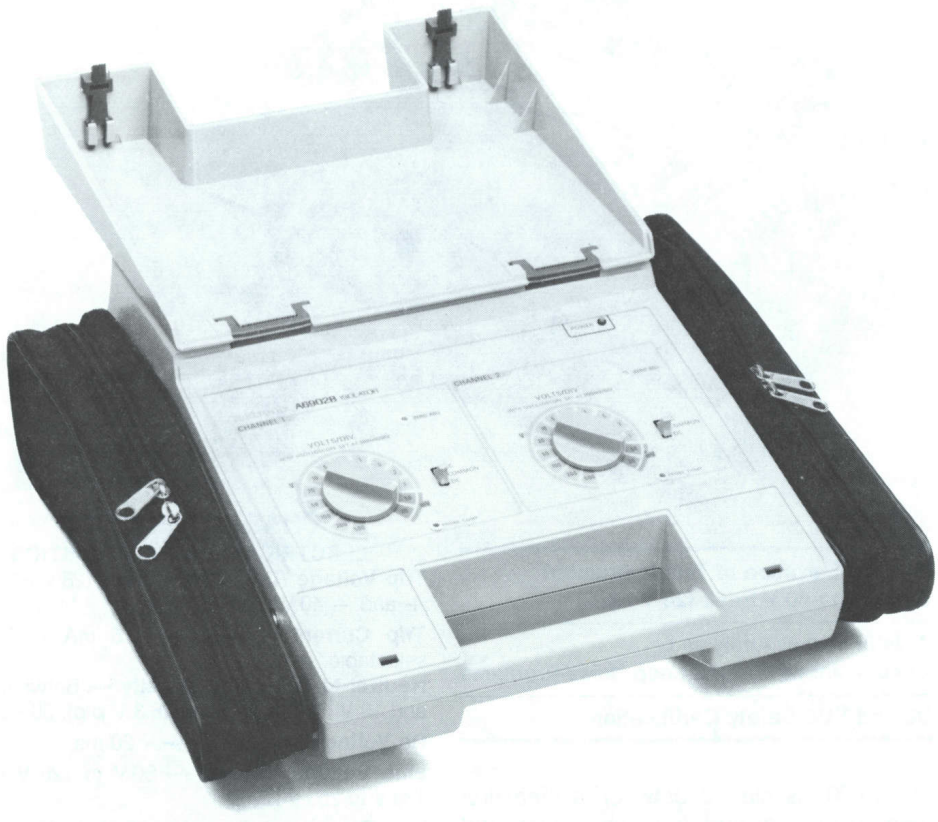
### Indirect Grounding

Safety standards specify indirect grounding as an alternative to direct grounding. All of the grounding requirements apply, except that the grounding circuit need not be completed until the available voltage or current exceeds a prescribed amount.

### Ground Isolation Monitor

The Tektronix A6901 Ground Isolation Monitor is an indirect grounding device. It is connected between the mains and the test instrument. When activated, it disconnects the protective grounding system and monitors the voltage and current of the isolated ground. If this voltage exceeds 40 volts peak, the A6901 disconnects the power to the test instrument, sounds an alarm, and re-connects the protective grounding conductor.

The A6901 can be used with any grounded test instrument. It also tests ground continuity of the mains and will not activate if the mains ground is inadequate. It solves the problems of defeating the protective ground and provides the means for valid measurements.



# *NEW* A6902B
## For 50 Ω or 1 MΩ Inputs

**Two Independently Isolated Channels**

**High Voltage/High CMRR**

**UL Certified to 3000 V/Channel (6000 V Maximum Channel Differential)**

**Dc to 20 MHz Bandwidth**

A dual-channel, optical- and transformer-coupled voltage isolator, the A6902B allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

The A6902B acts as a buffer between the test instrument and the system under test and extends the range of the test instrument to 3000 V (dc plus peak ac) with the larger industrial probe and to 500 V (dc plus peak ac) with the smaller signal probe. Both probes are quickly interchangeable at the cable connectors. The two pairs of probes and output cables are stored in removable side pouches for availability and convenience.

Designed for use with any dual-channel oscilloscope, the A6902B permits simultaneous observation of two signals at two different points in the same circuit; or signals in two different circuits without respect to common lead voltages.

The two channels can also be combined to function as an input to a differential amplifier.

Separate, calibrated controls for volts per division on each channel provide for precise floating measurements. The all-plastic case and external controls protect the user during control settings and other operations. Other than probe tip connections, the user is never in close proximity to hazardous voltages.

## CHARACTERISTICS
### ELECTRICAL CHARACTERISTICS

**Deflection Factor** — Probe Tip Sensitivity: 20 mV/div to 500 V/div in 1-2-5 sequence with oscilloscope set to 10 mV/div. Accuracy: ≤ ±5% of indicated V/div switch setting.

**Frequency Response** — Bandwidth: Dc coupled (to −3 dB points) is ≥20 MHz. Ac coupled (to lower −3 dB point) is ≤5 Hz .

**Transient Response** — Risetime: 17.5 ns (calculated from bandwidth).

**Maximum Working Voltage**

**Large Probe** — Probe Center Tip to Earth Ground: UL 3000 V. Probe Center Tip to Probe Common: UL 3000 V (dc + peak ac) to 450 kHz. See Figure 1 for voltage derating above 900 kHz. Probe Common to Earth Ground: UL 3000 V (dc + peak ac) to 250 kHz. See Figure 2 for voltage derating above 250 kHz.

**Small Probe (500 V)** — Probe Center Tip to Earth Ground: 500 V (dc + peak ac). Probe Center Tip to Probe Common: 500 V (dc + peak ac) to 3 MHz. See Figure 2 for voltage derating above 3 MHz. Probe Common to Earth Ground: 500 V (dc + peak ac) to 6 MHz. See Figure 2 for voltage derating above 6 MHz.

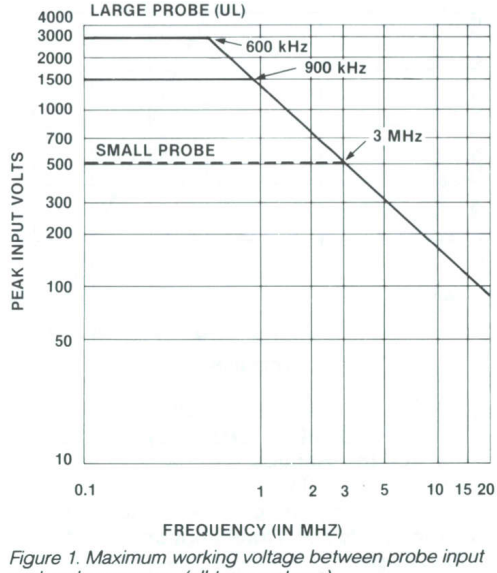



*Figure 1. Maximum working voltage between probe input and probe common (all temperatures).*

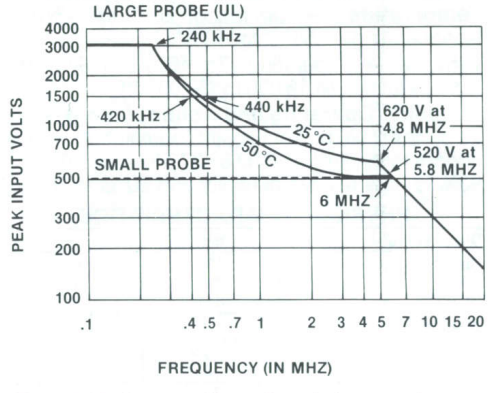



*Figure 2. Maximum working voltage between probe common and earth ground.*

**Maximum Input dV/dt** — 100 V/ns.

**Input Impedance** — Resistance: 10 MΩ ±3%. Capacitance: ≈19 pF with either probe.

**Output Impedance** — 50 Ω ±5%.

**Output Drive** — 4 V p-p into 1 MΩ.

**Common-Mode Capacitance** — 100 pF from probe common to earth ground.

**Maximum Common to Ground Slew Rate** — 500 V/μs.

**Tangential Noise** — 20.0 mV. Dc Drift With Temperature: ≤10.0 mV/°C (0.1 div/°C) at output. Range of Output Dc Level: At least +5 div from center screen.

**Channel Isolation** — Maximum Voltage: Using two 3,000 V UL probes is 6000 V (dc + peak ac) UL. Using two 500 V probes is 1000 V (dc + peak ac).

**Delay** — 51 ns ±3 ns (large probe), 52 ns ±3 ns (small probe), from probe input to instrument input. CH1, CH2 delay difference is ≤4 ns.

**Common Lead Signal Feedthrough** — −106 dB from probe input to output BNC to 500 Hz. See Figure 3 for derating above 500 Hz.

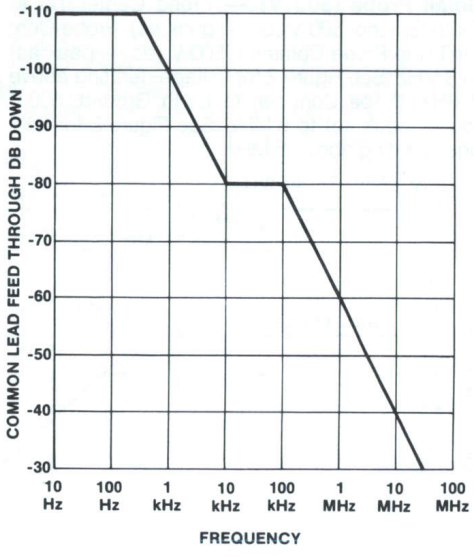



*Figure 3. Common-lead feedthrough characteristics.*

### POWER SOURCE CHARACTERISTICS

**Line Voltage Ranges** — Low: 90 V to 132 V. High: 180 V to 250 V.

**Line Frequency Range** — 48 Hz to 440 Hz.

**Maximum Power Consumption** — 24 W at 115 V, 60 Hz.

### ENVIRONMENTAL CHARACTERISICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: −55°C to +75°C.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

**Humidity (Operating and Nonoperating)** — Five cycles (120 hr total) with equipment tested nonoperating to MIL-STD-810C Method 507.1, at 90% to 95% relative humidity and 30°C to 60°C.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Height | 136 | 5.4 |
| Width | 394 | 15.5 |
| Depth | 344 | 13.5 |
| **Weight** | **kg** | **lb** |
| Net w/Accessories | 6.2 | 13.7 |
| Shipping | 8.0 | 17.7 |

## ORDERING INFORMATION

**A6902B** Isolator*[1]

**Includes:** Two 500 V isolation probes (010-0411-10); 0.15 ASB 250 V fuse (159-0054-00); 0.1 ASB 250 V fuse (159-0029-00—Europe); right angle power cord (161-0117-00); two 2 m, 50 Ω output cables (012-0204-00); operator manual (070-5614-00).

#### OPTIONS

**Option 02** — Additional two large probes.*[1]

**Option 09** — Additional two large probes plus two 4 mm banana adaptors.*[1]

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

**Option A2** — UK 240 V/13 A, 50 Hz.

**Option A3** — Australian 240 V/10 A, 50 Hz.

**Option A4** — North American 240 V/15 A, 60 Hz.

**Option A5** — Switzerland 220 V/10 A, 50 Hz.

*[1] *Contact your local sales office for price.*

#### OPTIONAL ACCESSORIES

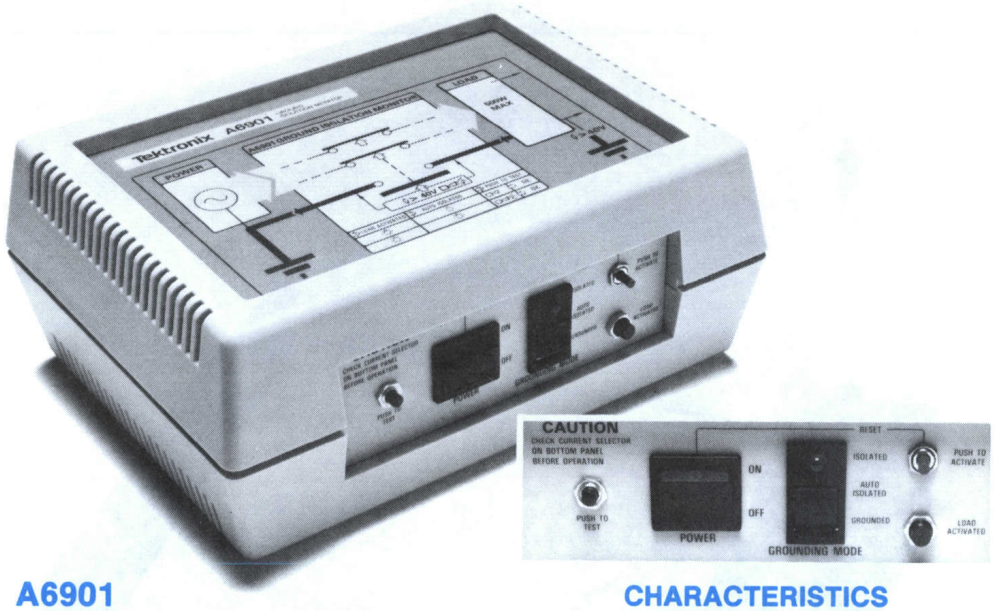
**BNC to Probe Tip Adaptor** — Order 013-0084-02 — **$10**

**BNC to Probe Tip Adaptor** — Order 015-0405-00 — **$20**

**Isolation Probe** — 3000 V.

**Cable Marker Bands**
(White) Order 334-2794-01 — **$ .05**
(Green) Order 334-2794-07 — **$ .05**

**Service Manual** — Order 070-5615-00




## A6901

**Permits Elevation of Test Instrument Chassis to 40 V Peak (28 V RMS)**

**Aids in Circuit Analysis or Circumventing Ground Loop Noise Problems**

**UL and VDE Safety Certification**

The A6901 is placed between a measurement instrument and its power source and acts as an indirect grounding device, allowing floating measurements to be made with operator protection.

The A6901 monitors the voltage on the isolated system. When the voltage exceeds 40 V peak (28 V RMS) the power source to the instrument is interrupted, the isolated grounding system is connected to the power source grounding system, and an audible alarm is sounded. Before power is supplied to the measurement instrument, the A6901 tests the power source for a functional ground*[1]. If a functional ground is not established, the ground isolation monitor will not go into isolated mode.

Applications for the A6901 include elevating a test instrument chassis to logic reference voltages for more accurate logic level measurements, and isolating a test instrument chassis from common-mode voltages present on ground systems to eliminate undesirable noise from signal measurements.

The A6901 also can be used to test power outlets for proper wiring.

*[1] *If the A6901 is used in conjunction with a GFI (Ground Fault Indicator), consult the GFI manual for compatibility information.*

## CHARACTERISTICS

### ELECTRICAL CHARACTERISTICS

**Trip Voltage (Dc)** — 40 V peak (28 V RMS) or + and − 40 V (within 5%).

**Trip Current** — 0.5 mA, 3.5 mA to 5 mA selectable.

**Neutral-to-Ground Continuity** — Between 3 V and 10 V RMS (8.5 V and 28.3 V p-p), 50 Hz.

**Dc Voltage Trip Delay** — <20 ms.

**Line Voltage Ranges** — 90 V to 128 V RMS, 180 V to 250 V RMS.

**Line Frequency Range** — 48 Hz to 66 Hz.

**Maximum Power Consumption (No External Load)** — 12 W at 115 V, 60 Hz.

**Load Power** — 500 W maximum

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: −15°C to +55°C (+5°F to +131°F). Nonoperating: −62°C to +85°C (−80°F to +185°F). Meets MIL-T-28800B, Class 3.

**Altitude** — Operating: To 4600 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft). Exceeds MIL-T-28800B, Class 3.

**Humidity** — Exceeds MIL-T-28800B, Class 3.

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Height | 87 | 3.4 |
| Width | 206 | 8.1 |
| Depth | 153 | 6.0 |
| **Weights** | **kg** | **lb** |
| Net (without accessories) | 1.4 | 3.0 |
| Shipping | 2.3 | 5.0 |

## ORDERING INFORMATION

**A6901** Ground Isolation Monitor — **$650**

**Includes:** Operator manual (070-3618-00.

#### INTERNATIONAL POWER PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16 A, 50 Hz.

**Option A2** — UK 240 V/13 A, 50 Hz.

**Option A3** — Australian 240 V/10 A, 50 Hz.

**Option A5** — Switzerland 220 V/10 A, 60 Hz.

(North American 240 V not available. Neutral not grounded in 240 V North American Systems.)





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## DIFFERENTIAL PROBES

Tek support four modes of differential measurements: the differential amplifier probe; the matched pair of probes; the isolation amplifier; and the ground interrupt monitor.

The P6046 is a 100 MHz differential amplifier in probe form. It connnects into one channel of a standard scope amplifier.

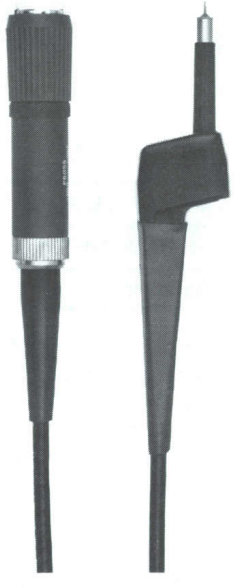
A matched pair of P6055 probes can produce CMRR ratios up to 20,000:1 with differential amplifiers. A single 10X probe has accuracy of 1% or less giving a scope-to-probe CMRR of no better than 50:1.

The A6902B provides differential capabilities for signals to 20 MHz, while rejecting up to 3,000 Volts of common mode.

The A6901 allows floating measurements within safe limits. It first checks for a good ground, then breaks the ground connection and continuously monitors the level of voltage elevation, and reconnects the ground if safe limits are exceeded.

## P6055

### 20,000:1 CMRR 10X with Readout



**High CMRR**

**Compact Size**

**Low Capacitance**

**Dc to 60 MHz**

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ±2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes provides the best possible system CMRR.

### CHARACTERISTICS

**CMRR** — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

**Attenuation** — Adjustable to 10X.

**Input Resistance** — 1 MΩ ±0.5%.

**Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

**Maximum Useful Bandwidth** — 60 MHz.

**Typical Probe Risetime** — 5.8 ns.

**Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz, p-p V derated to 100 V at 70 MHz.

### ORDERING INFORMATION

**P6055** 10X, Differential Probe
3.5 ft Cable. Order 010-6055-01 **$275**

**Includes:** Retractable hook tip (BB, 013-0107-05); 13 cm (5 inch) ground lead (175-0124-01); probe holder (352-0090-00); two electrical insulating sleeves (BP, 166-0404-01); two alligator clips (AS, 344-0046-00); adjustable tool (CP, 003-0675-01); hook tip (BU, 206-0114-00); 13 cm (6 inch) electrical ground lead (DF, 175-1256-00); 30 cm (12 inch) ground lead (175-0125-01); instruction manual (070-1115-00).

**Matched Pair of Two P6055 Probes.**
Order 015-0437-00 **$485**

**See page 446 for probe accessories.**

## P6046

### Dc to 100 MHz 1X Differential

**For 50Ω or 1 MΩ Inputs**

**1000:1 CMRR at 50 MHz**

**±250 V Maximum Voltage with 10X Attenuator**

**Dual Probe Tips for Greater CMRR at High Frequencies**

The P6046 Differential Probe and P6046 Amplifier Unit provide unique measurement capabilities with all Tektronix oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

### CHARACTERISTICS

**CMRR** — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz.

**Common-Mode Linear Dynamic Range** — ±5 V, ±50 V with 10X attenuator.

**Bandwidth** — Dc to 100 MHz (−3 dB). **Risetime** — 3.5 ns or less.

**Deflection Factor Range** — 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div).

**Input RC** — 1 MΩ paralleled by 10 pF or less.

**Input Coupling** — Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is −3 dB at 20 Hz, 2 Hz with 10X attenuator.

**Displayed Noise** — 280 μV or less (tangentially measured).

**Maximum Input Voltage** — ±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency.

**Output Impedance** — 50 Ω through a BNC-connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems.

**Probe Cable** — 6 ft long, terminated with special nine-pin connector.

### ORDERING INFORMATION

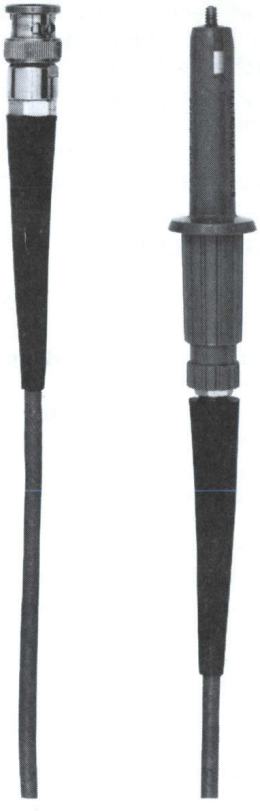
**P6046** 1X, 6 ft. FET Differential Probe with Amplifier and Power Supply
Order 010-6046-02 **$1,750**

**Includes:** 50 Ω termination (BR, 011-0049-01); amp and power supply (015-0106-00); 50 Ω coaxial cable (012-0076-00); hanger assembly (014-0029-00); carrying case (016-0111-01); 10X attenuator (010-0361-00); dual attenuator head (010-0419-00); swivel probe tip; spring ground contact; connector test point jack; instruction manual (070-0756-00).

**Without Amplifier and Power Supply**
Order 010-6046-01 **$925**

**Power Supply with Amplifier**
Order 015-0106-00 **$925**

## P6007 Dc to 25 MHz, 100X



### For 1 MΩ Inputs

**1500 V Dc**

**Low Capacitance Loading**

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

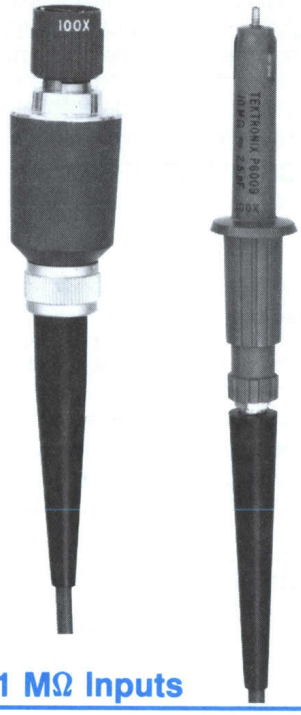
### ORDERING INFORMATION

**P6007** 100X, High Voltage Probe

**Includes:** Banana tip (AK, 134-0013-00); 0.055 inch diameter straight tip (AA, 206-0015-00); retractable hook tip (AN, 013-0071-00); 13 cm (5 inch) ground lead (175-0124-01); 30 cm (12 inch) ground lead (175-0125-01); hook tip (AG, 206-0105-00); probe holder (352-0090-00); two alligator clips (AS, 344-0046-00); instruction manual (070-0388-01).

| | |
|---|---|
| 3.5 ft Cable. Order 010-0150-00 | **$120** |
| 6 ft Cable. Order 010-0165-00 | **$120** |
| 9 ft Cable. Order 010-0152-00 | **$120** |
| 12 ft Cable. Order 010-0154-00 | **$120** |

## P6009 Dc to 120 MHz, 100X




### For 1 MΩ Inputs

**1500 V Dc**

**Dc to 120 MHz**

**Low Capacitance—2.5 pF**

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with Tektronix dc to 150 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides CRT Readout information when used with plug-in units and mainframes that have these features.

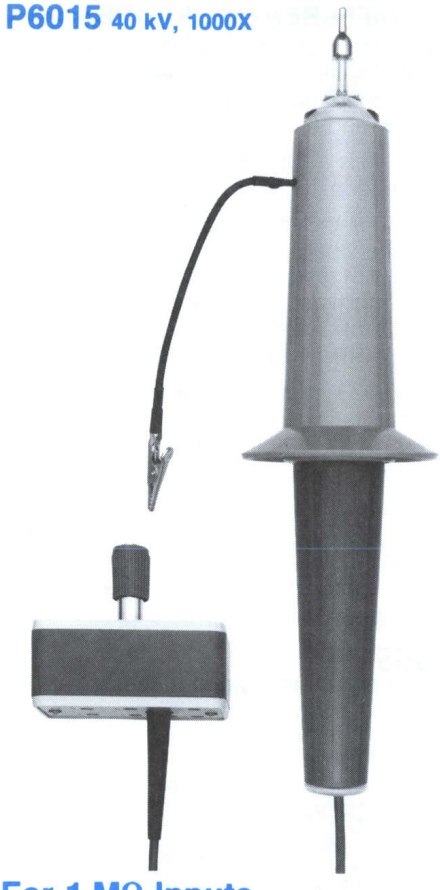
### ORDERING INFORMATION

**P6009** 100X High Voltage Probe

**Includes:** 30 cm (12 inch) ground lead (175-0125-01); 13 cm (5 inch) ground lead (175-0124-01); 7.5 cm (3 inch) ground lead (DD, 75-0263-01); probe holder (352-0090-00); 0.080 inch diameter spring tip (AB, 206-0060-00); two alligator clips (AS, 344-0046-00); banana tip (AK, 134-0013-00); 0.055 inch diameter straight tip (AA, 206-0015-00); retractable hook tip (AN, 013-0071-00); hook tip (AG, 206-0105-00); bayonet ground assembly (AJ, 013-0052-00); instruction manual (070-0401-01).

| | |
|---|---|
| 9 ft w/Readout. Order 010-0264-01 | **$195** |
| 9 ft w/o Readout. Order 010-0170-00 | **$195** |

## P6015 40 kV, 1000X



### For 1 MΩ Inputs

**Measure up to 40 kV Peak Pulse**

**Up to 20 kV Dc + Peak Ac**

**75 MHz Useful Bandwidth**

The P6015 Provides 1000X attenuation for oscilloscope measurements up to 40 kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in temperatures above 25°C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF and input resistance of 1 MΩ.

### ORDERING INFORMATION

**P6015** 1000X, High Voltage Probe

10 ft Cable. Order 010-0172-00 **$650**

**Includes:** BNC compensating box (015-0049-00); high-voltage dielectric fluid can (AU, 252-0120-00); alligator clip (AQ, 344-0005-00); carrying case (016-0128-02); probe holder (352-0056-00); instruction manual (070-0373-02).

### CHARACTERISTICS

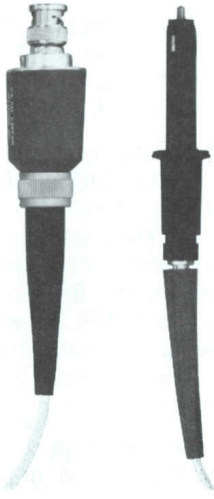
| | Attenuation | Accuracy | Input Resistance | Input Capacitance | | | Probe Risetime | Aberrations | Bandwidth | Nominal Cable Length (ft) | Maximum Dc Voltage | Derated Above | Derated to @ Frequency | Compensation Range (pF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 3½ ft | 6 ft | 9 ft | | | | | | | | |
| P6007 | 100X | 3% | 10 MΩ | 2 pF | 2.2 pF | 2.4 pF | 14.0 ns | ±3 | 25 MHz | 3½, 6, 9, 12 | 1.5 kV | 200 kHz | 2 kV @ 5 MHz | 15 to 55 |
| P6009 | 100X | 3% | 10 MΩ | | 2.5 pF | | 2.9 ns | ±3 | 120 MHz | 9 | 1.5 kV | 200 kHz | 300 V @ 20 MHz | 15 to 47 |
| P6015 | 1000X | Adjustable | 100 MΩ | 3 pF (10 ft only) | | | 4.0 ns | ±5 | 75 MHz | 10 | 20.0 kV | 100 kHz | 2 kV @ 20 MHz | 12 to 47 |

**Included Accessories with double alpha codes are pictured on pages 446 and 447**



**To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99**

## P6008 (Environmental)
**100 MHz, 10X**



### For 1 MΩ Inputs

**−50°C to +150°C Temperature Range**

The P6008 Environmental Probe is designed to operate over −50°C to +150°C for the probe body and cable; the compensation box operates from −15°C to +55°C. It is designed for use with Tektronix dc to 100 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance to 1 MΩ.

#### CHARACTERISTICS

**Attenuation** — 10X.

**Input Resistance** — 10 MΩ.

**Input Capacitance** — ≈7.5 pF when used with an instrument having a 20 pF input capacitance.

**Bandwidth** — Dc to 100 MHz.

**Voltage Rating** — 600 V dc, ac peak, or dc and ac peak combined. P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

**Cable Length** — 1.8 m (6 ft).

#### ORDERING INFORMATION

**P6008** 10X, 6 ft Environmental Probe
Order 010-0129-01 **$240**

**Includes:** Banana tip (AK, 134-0013-00); 300 mm (12 in) ground lead (BD, 175-0125-01); alligator clip (AR, 344-0045-00); retractable hook tip (AP, 013-0071-00); instruction manual (070-0362-01).

**Included Accessories with double alpha codes are pictured on pages 446 and 447.**

## P6401 Logic Probe

**Illuminated Probe Tip Indicates Logic Level**

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any five volt supply.

Two bright lights in the probe tip indicate condition of the logic signal.

#### CHARACTERISTICS

**POWER SUPPLY**

**Low State Input Voltage Range** — 0 V to +0.7 V ±0.125 V.

**High State Input Voltage Range** — 2.175 V ±0.125 V to V cc.

**Miminum Recognizable Pulse Width** — 10 ns.

**Impedance** — ≈7.5 kΩ paralleled by ≈6 pF.

**Miminum Circuit Resistance for Open Circuit Indication** — 10 kΩ.

**Maximum Safe Input** — ±150 V (dc or RMS).

**Mimimum Recognizable Strobe Pulse Width** — 20 ns.

**Maximum Safe Strobe Input** — ±30 V (dc or RMS).

**Strobe Input Impedance** — 5.6 kΩ within 20%.

**P6401** 1.5 m Logic Probe
Order 010-6401-01 **$170**

**Includes:** Probe tip hook (BU, 206-0114-00); strobe lead (175-0958-01); strobe lead (175-0958-00); probe tip to 0.025 inch square pin adaptor (AH, 206-0137-01); white plug (348-0023-00); two alligator clips (AS, 344-0046-00); accessory pouch (016-0537-00); data sheet (062-1693-00).

## P6420 RF Probe

### For 10 MΩ Inputs

**10 kHz to 1 GHz Bandwidth**

**Dc V Output/RMS of Sine Input**

The P6420 RF probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the RMS value of a sinewave input compatible with any DMM with an input resistance of 10 MΩ.

#### CHARACTERISTICS

**Voltage Range** — 0.5 V to 25 V RMS (70.7 V p-p).

**Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).

**Frequency Response** — 100 kHz to 300 MHz (±0.5 dB). 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).

**Input Capacitance** — ≈3.7 pF.

**Maximum Input Voltage** — 42.4 V (peak ac + dc).

**Temperature Range** — Nonoperating: −55°C to +75°C. Operating: +15°C to +35°C.

**Length** — Probe Only: 96 mm. Cable Only: 2 m.

#### ORDERING INFORMATION

**P6420** 2 m RF Probe
Order 010-6420-03 **$145**

**Includes:** Retractable probe tip (CB, 013-0097-01); two alligator clips (AS, 344-0046-00); two replaceable*[1] probe tips; electrical insulating sleeve (BP, 166-0404-01); 75 mm (3 in) ground lead (DC, 175-0849-00); 130 mm (6 in) ground (DE, 175-1017-00); probe holder (352-0351-00); BNC female to dual banana adaptor (103-0090-00); data sheet (062-2764-00).

*[1] *Available in packages of ten (order 206-0230-03) or 100 (order 206-0230-04) (CF).*

#### OPTIONAL ACCESSORIES

Probe cables usable with the P6420 (does not change electrical specifications)

**1 m** — Order 175-9419-00 **$15**
**2 m** — Order 175-9409-00 **$17**
**3 m** — Order 175-9410-00 **$19**

## P6602 Temperature Probe

## For DMM Input

**UL Listed**

The P6602 Temperature Probe is a temperature measuring device designed to operate with the 2236 Digital Multimeter. The temperature sensory element consists of a thin-film platinum resistor in the tip of the probe. Measurements are made by touching the probe tip to the surface under test. The resulting resistor value is measured by the multimeter through a two-conductor cable. The tip and cable assembly are replaceable.

### CHARACTERISTICS

**Operating Temperature Range —** Probe Head and Cable: −62°C to +230°C (−80°F to +446°F). Banana Jack Style Connector: −15°C to +85°C.

**Voltage —** 400 V peak.

### ORDERING INFORMATION

**P6602** Temperature Probe
1.5 m Cable. Order 010-6602-00 **$225**
**Includes:** Instruction manual (070-4377-00).

### CURRENT PROBES

Current probes provide a method to measure the current flowing in a circuit from dc to 1000 A. For instance, their use can eliminate the calculations that would be required to determine the current from the voltage drop across a current sampling resistor.

Two types of current probes are available, the traditional ac only probe and the "Hall effect" type. Ac only current probes use a transformer to convert current flux into ac signals and have a frequency response from a few hundred hertz to 100 MHz. Hall effect current probes include semiconductors to provide a frequency response from dc to 50 MHz.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the mΩ to low Ω range. Current probes can be used for differential measurements; where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. A measurement of the current waveform is necessary to obtain the total picture.

A current probe is used by clipping its jaws around the wire that is carrying the current to be measured. Because it is "noninvasive", a current probe imposes less loading than other probes (typically less than a few nanohenrys in series with the wire at a capacitance of less than 1 pF). Differential current measurements are made by passing the two wires (in correct phase) through the current probe jaws.

The CT-5 increases the high-current measuring capability of most current probes by either 20:1 or 1000:1.

### CURRENT PROBE SELECTION GUIDE

| Type | Bandwidth Hz to MHz | Displayed Current/Div | Maximum Current | | | | | Saturation | | Page | Prices |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Peak Pulse | Dc + pk Ac | Ac P-P | Derate Below | Derate Above | Dc | Amp-S Product | | |
| **A6302/ AM 503** | Dc 50 | 1 mA to 5 A*1 | 50 A | 20 A | 40 A | | 20 kHz | 20 A | 100 x 10⁻⁶ | 443 | $1,690 |
| with CT-5 | 0.5 20 | 20 mA to 5 kA*1 | 50 kA | | 40 kA | 20 Hz | 1.2 kHz | | 0.1 | 445 | $2,890 |
| **A6303/ AM 503** | Dc 15 | 10 mA to 50 A*1 | 500 A | 100 A | 200 A | | 20 kHz | 100 A | 10,000 x 10⁻⁶ | 443 | $2,195 |
| **P6021** w/Passive Term. | 120 60 | 20 mA or 100 mA*1 | 250 A | | 15 A | 300 Hz | 5 MHz | 0.5 A | 500 x 10⁻⁶ | 444 | $430 |
| + CT-5 | 120 20 | 400 A or 100 kA*1 | 50 kA | | 2000 A | 300 Hz | 1.2 kHz | 20 A | 0.5 | 445 | $1,630 |
| with 134 | 12 38 | 1 mA to 1 A*2 | 250 A | | 15 A | 230 Hz | 5 MHz | 0.5 A | 500 x 10⁻⁶ | 444 | $1,105 |
| + CT-5 | 12 20 | 20 mA to 1 kA*2 | 15 kA | | 2000 A | 230 Hz | 1.2 kHz | 20 A | 0.5 | 445 | $2,305 |
| **P6022** w/Passive Term. | 935 120 | 10 mA or 100 mA*1 | 100 A | | 6 A | 3 kHz | 10 MHz | 0.2 A | 9 x 10⁻⁶ | 447 | $475 |
| with 134 | 100 65 | 1 mA to 1 A*2 | 100 A | | 6 A | 1.3 kHz | 10 MHz | 0.2 A | 9 x 10⁻⁶ | 447 | $1,150 |
| **CT-1** | 25 k 1000 | 0.5 mA*1 (5 mV/mA) | 12 A | | 1.4 A | | | 0.2 A | 1 x 10⁻⁶ | 445 | $175 |
| **CT-2** | 1.2 k 200 | 0.1 mA*1 (1 mV/mA) | 36 A | | 7 A | | | 0.2 A | 50 x 10⁻⁶ | 445 | $200 |

*1 Scope set at 10 mV/div.
*2 Scope set at 50 mV/div.





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## A6302 Current Probe

**20 A Ac and Dc Current Measurements**

**Dc to 50 MHz Bandwidth**

**Peak Pulse Measurements to 50 A, 50,000 A with the CT-5 Current Probe**

**Ac or Dc Coupling**

**Small Loading—0.1 Ω Insertion Z at 1 MHz, 0.5 Ω at 50 MHz**

## A6303 Current Probe

**100 A Ac and Dc Current Measurements**

**Peak Pulse Measurement to 500 A**

**Ac or Dc Coupling**

**25 in x 21 mm (1 in x 0.83 inch) Jaw Opening**

**Minimal Loading—0.02 Ω Insertion at 1 MHz, 0.15 Ω at 15 MHz**

The Tektronix A6302 and A6303 Current Probes are designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope. Both probes are used to make SCR, power supply, industrial control and motor start-up current measurements. The A6303 is especially recommended for measuring current in x-ray tubes to ensure compliance with PL 90-602, the Radiation Control for Health and Safety Act of 1968.

The A6302 and A6303 are valuable measurement tools when low loading is important, as when testing high impedance points or with current dependent devices.

Both probes make ac or dc coupled current measurements by the simple act of opening their sliding jaws and placing them around the conductor to be measured. For differential or sum measurements just place properly phased conductors in the probe jaw.

Suggested measurements for the A6302 and A6303 Current Probes include:
X-ray tube currents
SCR currents
Power supply currents
Motor start-up currents
Industrial control currents
Relay currents
Common-mode rejection of dc and ac currents

### CHARACTERISTICS

| | A6302 & AM 503 | A6303 & AM 503 |
|---|---|---|
| Sensitivity: Scope @ 10 mV/div Accuracy 3% | 1 mA/div to 5 A/div | 10 mA/div to 50 A/div |
| Bandwidth | Dc to 50 MHz | Dc to 15 MHz |
| Risetime | 7 ns | 23 ns |
| Max Ac Current CW | 40 A p-p | 200 A p-p |
| Derated above | 20 kHz 2.5 A @ 10 MHz | 20 kHz 12 A @ 10 MHz |
| Maximum Current Peak Not to Exceed A-S product | 50 A | 500 A |
| A-S Product | 100 x $10^{-6}$ | 10,000 x $10^{-6}$ |
| Insertion Z | 0.1 Ω @ 5 MHz 0.5 Ω @ 50 MHz | 0.02 Ω @ 1 MHz 0.15 Ω @ 15 MHz |
| Max Hardware Volts | 500 V | 700 V |
| Max Conductor Diameter | 0.15 inch | 0.83 inch |
| System Prop Delay | ≈30 ns | ≈40 ns |
| Cable Length | 2 m | 2 m |
| Tangential Noise | 0.3 mA | 3 mA |
| Aberrations | ±5% | ±5% |
| Magnetic Susceptability | 250 μA/Gauss | 25 mA/Gauss |
| Operating Temp | 0°C to +50°C | 0°C to +50°C |

*Note: A6302/AM 503 or A6303/AM 503 calibrated as a set.*

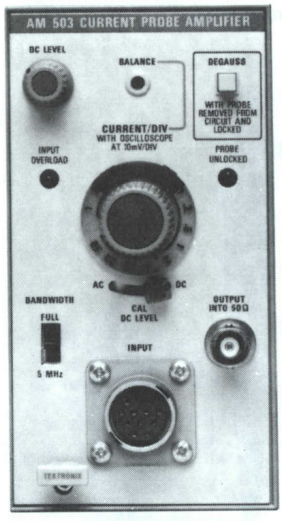
### ORDERING INFORMATION

**A6302** 2 m Current Probe **$565**

**Includes:** Miniature alligator clips (AS, 344-0046-00); 130 mm (5 in) probe ground lead (DD, 175-0124-01); 75 mm (3 in) probe ground lead (DD, 175-0263-01); instruction manual (070-3905-01).

**A6303** 2 m Current Probe **$1,070**

**Includes:** Carrying case (016-0622-00); instruction manual (070-3906-01).




## AM 503 Current Probe Amplifier

**For 50 Ω/1 MΩ Inputs**

The AM 503 operates in any one of the TM 500 power modules and is connected to either the A6302 or A6303 probes through a multipin connector.

It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. Ac coupling allows the measurement of low amplitude signals on a high-level dc current. A front-panel light warns of input currents above 100 A dc with the A6303 or 20 A dc with the A6302. A push button allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the A6303/AM 503 can be displayed on any oscilloscope that has at least a 50 MHz bandwidth and a 10 mV sensitivity. The A6302/AM 503 can be used on a 75 MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50 Ω recording instrument, or a 50 Ω termination which is supplied. See page 379 for a complete description of the AM 503.

### ORDERING INFORMATION

**AM 503** Current Probe Amplifier **$1,125**

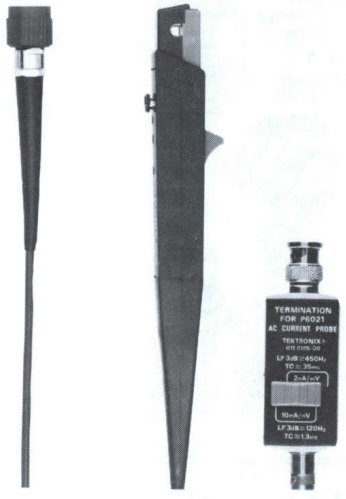
**Includes:** 50 Ω BNC cable (012-0057-01); 50 Ω BNC termination (BR, 011-0049-01); instruction manual (070-2052-01).

The AM 503 Current Probe Amplifier requires one of the TM 500 Series power modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel of the power module.

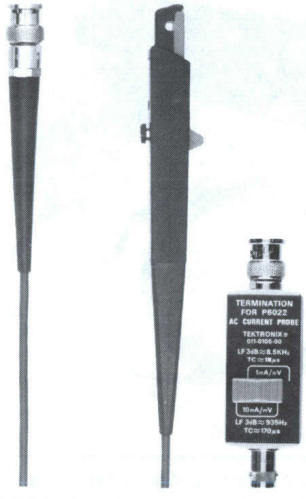
**TM 501** Power Module **$425**
**Option 02** — Interface. **+$60**

**TM 503** Power Module **$390**
**Option 02** — Interface. **+$90**

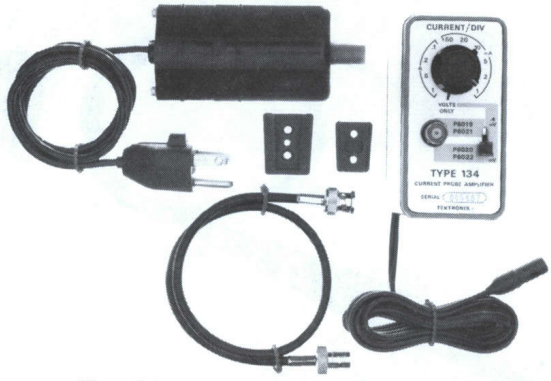
## P6021 with Termination




## P6022 with Termination




## 134 Current Probe Amplifier




**For 1 MΩ Input with Passive Termination**

**For 50 MΩ/1 MΩ Input with 134**

**Clip-on Capability**

**Shielded Probe Heads**

The P6021 and P6022 Current Probes and 134 Current Probe Amplifier provide versatility in a user-assembled ac current measurement system. Both probes provide accurate current measurements over a wide range of frequencies and are used with real-time oscilloscopes. They can be used with 1 MΩ input instruments with their passive terminations, or with 50 Ω and 1 MΩ input instruments with the 134 Amplifier. Both avoid breaking a circuit by clipping onto a conductor. Just open the spring-loaded slide, place the conductor into the slot and release the slide. No electrical connection is required.

Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the circuit under test.

### P6021 Current Probe

For general purpose applications the P6021 provides wide-band performance with excellent low-frequency characteristics. Bandwidth is 120 Hz to 60 MHz. Passive termination is switchable from 2 mA/mV to 10 mA/mV.

### P6022 Current Probe

The extra small size of the P6022 makes it ideally suited to measure current in compact semiconductor circuits. Bandwidth is 935 Hz to 120 MHz. Passive termination is switchable from 1 mA/mV to 10 mA/mV.

The 134 is used to extend the measurement capabilities and sensitivity of the P6021 or P6022 Current Probes. A Current/Div switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 with a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the Current/Div switch in the Volts position.

## PERFORMANCE CHARACTERISTICS

| | P6021 with Passive Termination | | P6022 with Passive Termination | | Probe with 134 Amplifier | |
|---|---|---|---|---|---|---|
| | | | | | P6021 | P6022 |
| Accuracy 3% Sensitivity | 2 mA/mV | 10 mA/mV | 1 mA/mV | 10 mA/mV | 1 mA to 1 A/div @ 50 mV/div | |
| Bandwidth<br>Low −3 dB<br>High −3 dB | 450 Hz<br>60 MHz | 120 Hz<br>60 MHz | 8.5 kHz<br>100 MHz | 935 Hz<br>120 MHz | 12 Hz<br>38 MHz | 100 Hz<br>65 MHz |
| Risetime | 5.8 ns | 5.8 ns | 2.7 ns | 1.7 ns | 9.2 ns | 5.4 ns |
| Droop TC | 0.35 ms | 1.3 ms | 18.7 μs | 0.17 ms | 13 ms | 1.6 ms |
| Maximum Ac CW<br>From<br>To | 15 A peak<br>1.2 kHz<br>5 MHz | 15 A peak<br>300 Hz<br>5 MHz | 6 A peak<br>10 kHz<br>10 MHz | 6 A peak<br>3 kHz<br>10 MHz | 15 A peak<br>230 Hz<br>5 MHz | 6 A peak<br>1.3 kHz<br>10 MHz |
| Maximum Peak Current | 250 A | 250 A | 100 A | 100 A | 250 A | 100 A |
| Amp/Second Product | $500 \times 10^{-6}$ | $500 \times 10^{-6}$ | $9 \times 10^{-6}$ | $9 \times 10^{-6}$ | $500 \times 10^{-6}$ | $9 \times 10^{-6}$ |
| Maximum Dc | 0.5 A | 0.5 A | 0.5 A | 0.5 A | 0.5 A | 0.5 A |
| Insertion Z (Ω) | 0.03 @ 1 MHz<br>1.0 @ 60 MHz | | 0.03 @ 1 MHz<br>0.2 @ 120 MHz | | 0.03 @ 1 MHz<br>1.0 @ 38 MHz | 0.03 @ 1 MHz<br>0.2 @ 65 MHz |
| Propagation Delay (ns)<br>5 ft<br>9 ft | 9<br>15 | 9<br>15 | 9<br>15 | 9<br>15 | 9<br>15 | 9<br>15 |
| Maximum Voltage Barewire | 600 V | 600 V | 600 V | 600 V | 600 V | 600 V |
| Net Weight | ≈1 lb | | ≈1 lb | | ≈5 lb | |
| Maximum Conductor Size | 0.15 in dia | | 0.1 in dia | | 0.15 in dia | 0.1 in dia |
| Operating Temperature | 0°C to +50°C | | 0°C to +50°C | | 0°C to +50°C | |

## ORDERING INFORMATION

**P6021** Current Probe

**Includes:** 13 cm (5 inch) ground lead (DD, 175-0125-01); two alligator clips (AS, 344-0046-00); 7.5 cm (3 inch) ground lead (DD, 175-0263-01); instruction manual (070-0947-00).

**With 5 ft. Cable and Termination**
Order 015-0140-02 **$430**

**With 9 ft. Cable and Termination**
Order 015-0140-03 **$430**

**With 5 ft. Cable and no Termination**
Order 010-0237-02 **$370**

**With 9 ft. Cable and no Termination**
Order 010-0244-02 **$370**

**P6022** Current Probe

**Includes:** Same as P6021.

**With 5 ft. Cable and Termination**
Order 015-0135-00 **$475**

**With 9 ft. Cable and Termination**
Order 015-0135-01 **$475**

**With 5 ft. Cable and no Termination**
Order 010-0238-00 **$380**

**With 9 ft. Cable and no Termination**
Order 010-0238-02 **$380**

**134** Current Probe Amplifier

**Includes:** Hanger assembly (014-0029-00); cable assembly (012-0104-00); instruction manual (070-0990-01).

**For 110 V ac.** Order 015-0057-02 **$625**
**For 230 V ac.** Order 015-0057-03 **$675**

## OPTIONAL ACCESSORIES
**(for P6021, P6022, and 134)**

**Carrying Case** — For P6021 or P6022, and a 134 Amplifier. Order 016-0087-01 **$25**

**Passive Termination** —
(P6021) Order 011-0105-00 **$95**
(P6022) Order 011-0106-00 **$115**

**Power Supply** —
110 V ac. Order 015-0058-01 **$155**
230 V ac. Order 015-0059-01 **$240**





To order, call your local Tektronix Sales Office, or call Tek's National Marketing Center, toll free: 1-800-426-2200, Ext 99. In Oregon call collect: (503) 627-9000, Ext. 99

## CT-1/CT-2 Current Probes

**The 1 GHz CT-1 is Used with 50 Ω Systems, or Wide Band Oscilloscopes, It has a Minimum Loading Effect on a 50 Ω Environment**

**The CT-2 is Used with Oscilloscopes Up to 100 MHz Bandwidth, It is Insulated for Limited Space Applications**

The CT-1 and CT-2 Current Probes are designed for permanent or semi-permanent in-circuit installation. Each probe consists of a current transformer, an interconnecting cable and a termination. The current transformers are traversed by a small hole through which a current carrying conductor is passed during circuit assembly.

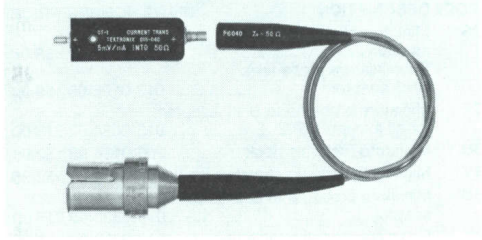
One probe cable can be used to monitor several current transformers that have been wired into a circuit.

### CHARACTERISTICS

| | CT-1 | CT-2 |
|---|---|---|
| Sensitivity | 5 mV/mA | 1 mV/mA |
| Accuracy | ±3% | ±3% |
| Risetime | 350 ps | 500 ps |
| Frequency Response | | |
| Low: −3 dB | 25 kHz | 1.2 kHz |
| High: −3 dB | 1 GHz | 200 MHz |
| Insertion Impedance: | | |
| at 10 MHz | ≈1 Ω | 0.1 Ω |
| at 100 MHz | 2 Ω | 0.5 Ω |
| Capacitive Loading Barewire | 1.5 pF for #14 | 1.8 pF for #16 |
| Maximum Barewire Voltage | 1000 V | 1000 V |
| Dc Saturation Current: Current to Reduce L/R by X2 | 75 mA | 175 mA |
| Pulse Current Rating*[1] Not to Exceed: | 12 A | 36 A |
| Amp S Product*[1] | 1 x $10^{-6}$ | 50 x $10^{-6}$ |
| Maximum CW Current*[1] | 450 mA | 2.5 A |
| Cable Length | 18 inch | 42 inch |
| Prop Delay | 3.25 ns | 6.1 ns |
| Cable Connector | GR874 | BNC |
| Operating Temperature | −25°C to +65°C | |

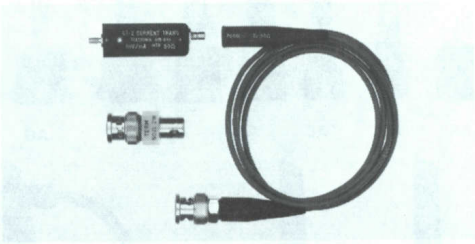
*[1] *With 50 Ω termination. Values are reduced by a factor of 2 if unterminated.*

### CT-1 with Probe Cable



The CT-1 Probe Cable (010-0133-00) provides the connection between the CT-1 current transformer and a GR scope input. This cable can also be used with other test point connectors such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF connectors.

### CT-2 with Probe Cable



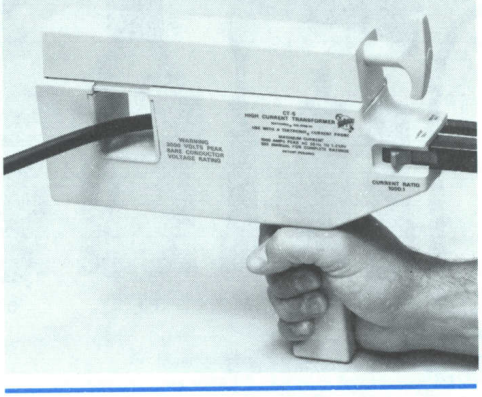
The CT-2 Probe Cable (010-0164-00) is used to connect the CT-2 current transformer with a BNC oscilloscope input. A 50 Ω termination is used to terminate the cable at the high impedance input of an oscilloscope.

### ORDERING INFORMATION

**CT-1** Current Probe
**Includes:** Instruction manual (070-0375-01).
Current Transformer and Probe Cable.
Order 015-0041-00 **$175**
Current Transformer Only.
Order 015-0040-00 **$105**
P6040 Probe Cable Only.
Order 010-0133-00 **$80**

**CT-2** Current Probe
**Includes:** 50 Ω termination (BR, 011-0049-01); instruction manual (070-0406-01).
Current Transformer, Probe Cable, Termination. Order 015-0047-00 **$200**
Current Transformer Only.
Order 015-0046-00 **$120**
P6041 Probe Cable Only.
Order 010-0164-00 **$60**

## CT-5 Continuous Currents to 1000 A Peak



**1.5 Inch Diameter Conductors**

**Measurements on Bare Conductors to 3000 V**

**Nullifies Dc Effects to 300 A w/Dc Bucking Coil**

**Pulsed Currents to 50 kA**

The CT-5 is a clip-on high-current transformer that extends the measurement capability of the Tektronix P6021 and A6302 clip-on current probes. Maximum low-frequency performance is obtained using the A6302/AM 503 Dc Current Probe. Pulse current to 50,000 amps may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 Current Probe Amplifier may also be used for measurements at normal line frequency and above. (The P6022 and CT-5 are not compatible with each other.) The CT-5 has receptacles for current probes in either 20:1 or 1000:1 step-down ratios. The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. The core and shield assembly are insulated from the windings and the handle. This allows measurements on bare wires to 3000 V, and to 10 kV RMS with a high voltage bushing.

A dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading measurements. This is very useful for measuring ac signals on top of a dc voltage level.

### CT-5 CHARACTERISTICS

The following are characteristics of the CT-5 using either the A6302/AM 503 or P6021/134 combinations.

**Risetime** — 17.5 ns or less.

**Insertion Impedance** — ⩽20 μΩ at 60 Hz; 20 mΩ at 1 MHz.

**Current Range** — 20 mA/div to 100 A/div with A6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with A6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio).

**Accuracy** — ±4%. Maximum Current is 1000 A peak cw.*[1]

**Maximum Voltage** — Of circuit test is 3000 V (barewire).

**Maximum Dc Bucking Current** — 300 mA to buck out 300 A dc (using dc bucking coil).

*[1] *Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.*

### CT-5 CURRENT MEASUREMENT COMBINATIONS

| Product | Bandwidth | A-s Product | Maximum Current RMS | Maximum Current Peak Pulse |
|---|---|---|---|---|
| CT-5/A6302/AM 503 | 0.5 Hz to 20 MHz | 0.1 | 700 A | 50 kA |
| CT-5/P6021/134 | 12 Hz to 20 MHz | 0.5 | 700 A | 15 kA |
| CT-5/P6021/Term | 120 Hz to 20 MHz | 0.5 | 700 A | 50 kA |

### PHYSICAL CHARACTERISTICS

| Dimensions | mm | in |
|---|---|---|
| Width | 57 | 2.3 |
| Height | 241 | 9.5 |
| Depth | 266 | 10.5 |
| **Weight** | **kg** | **lb** |
| Net | 1.8 | 4.0 |

### ORDERING INFORMATION

**CT-5** Current Probe
**Includes:** Carrying case (016-0191-03); 12 in wide, 4 ft long high voltage bushing (015-0194-00); instruction manual (070-1130-00).
Includes Dc Bucking Coil.
Order 015-0189-01 **$1,200**
Without Dc Bucking Coil.
Order 015-0189-00 **$1,100**

### OPTIONAL ACCESSORIES

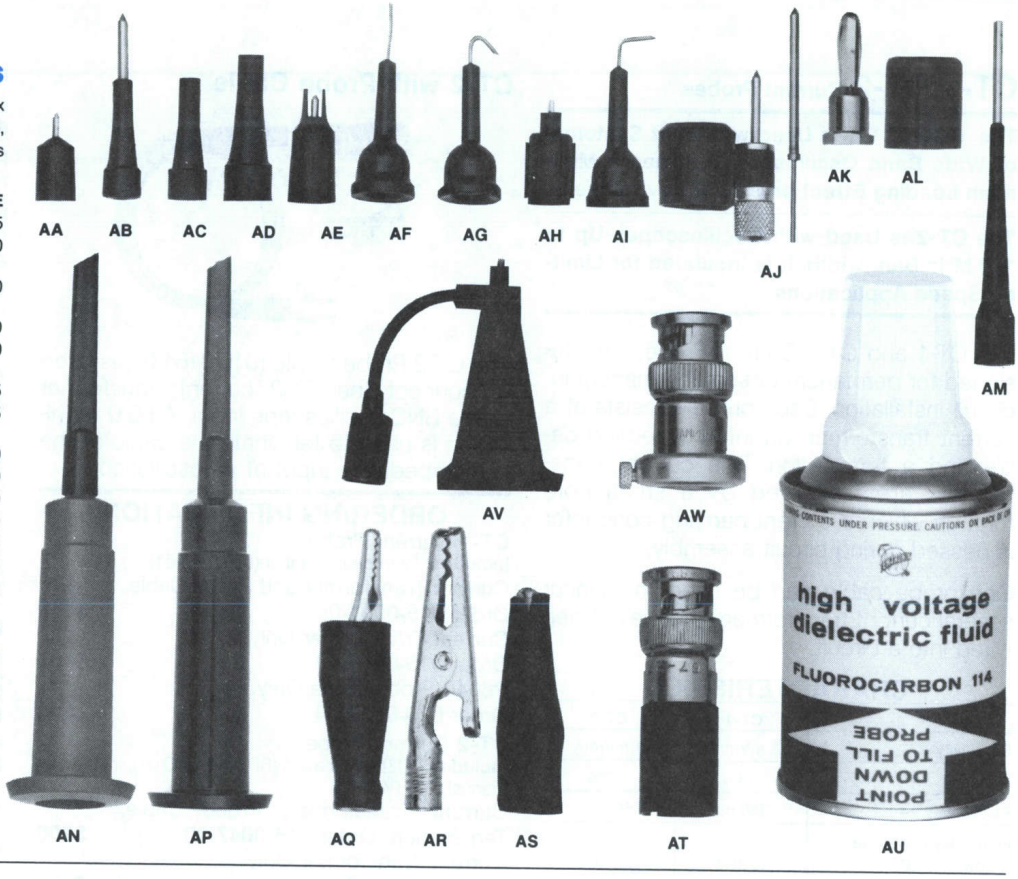
**Dc Bucking Coil** — Order 015-0190-00 **$300**

**High-Voltage Bushing** — 12 in wide, 4 ft long. Order 015-0194-01 **$50**

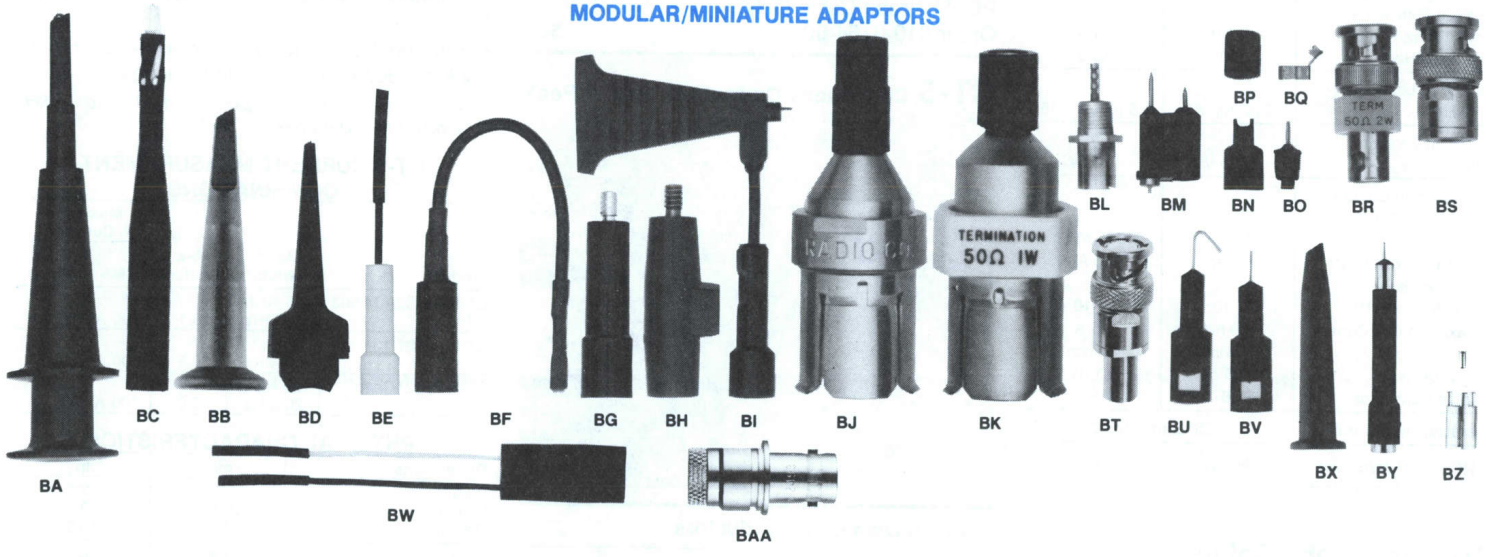
## SCREW-ON PROBE TIP AND ACCESSORIES

The following tips and adaptors can be used on all Tektronix Probes that accept a #6-32 screw-on tip, including the P6006, P6007, P6008, P6009, P6028, and P6060 Probes and others with 6-32 adaptor.

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| AA | Probe straight tip (0.055 in dia) | 206-0015-00 | $1.25 |
| AB | Probe spring tip (0.080 in dia) | 206-0060-00 | $2.00 |
| AC | Probe spring tip (accepts 0.065 in dia pin) | 206-0061-00 | $1.50 |
| AD | Probe spring tip (accepts 0.068 in dia pin) | 206-0168-00 | $3.00 |
| AE | IC test tip | 206-0203-00 | $1.50 |
| AF | Probe long straight tip (0.032 in dia) | 206-0104-00 | $1.15 |
| AG | Probe hook tip | 206-0105-00 | $1.15 |
| AH | Probe ground lead adaptor (#6-32 to 0.025 in square pin closing) | 206-0137-01 | $2.50 |
| AI | Probe right angle hook tip | 206-0185-00 | $1.50 |
| AJ | Bayonet ground assembly | 013-0052-00 | $8.50 |
| AK | Probe banana tip | 134-0013-00 | $1.00 |
| AL | Probe ground cover (for P6009) | 166-0428-00 | $1.35 |
| AM | Probe calibration tip (0.063 in dia) | 206-0100-00 | $10.50 |
| AN | Probe retractable hook tip | 013-0071-00 | $3.50 |
| AP | Probe retractable hook tip (for P6008E) | 013-0071-01 | $3.00 |
| AQ | Alligator clip | 344-0005-00 | $4.00 |
| AR | Alligator clip | 344-0045-00 | $0.80 |
| AS | Miniature alligator clip | 344-0046-00 | $2.15 |
| AT | Probe tip to BNC adaptor | 013-0054-00 | $15.00 |
| AU | High-voltage dielectric fluid 3 oz | 252-0120-00 | $5.00 |
| AV | Probe pin tip (accepts 0.025 in IBM SLT in) | 206-0134-03 | $4.50 |
| AW | Probe tip to BNC adaptor (for P6028) | 013-0056-00 | $17.25 |

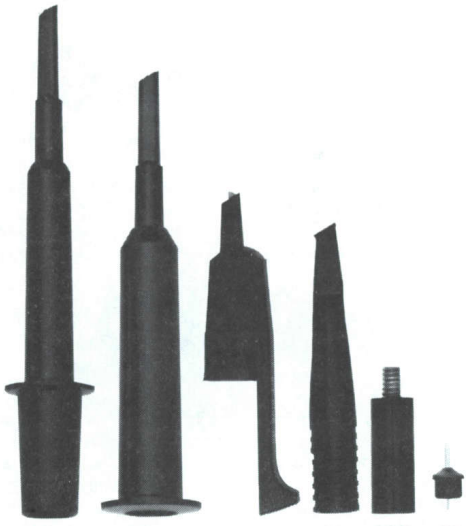



## MODULAR/MINIATURE ADAPTORS



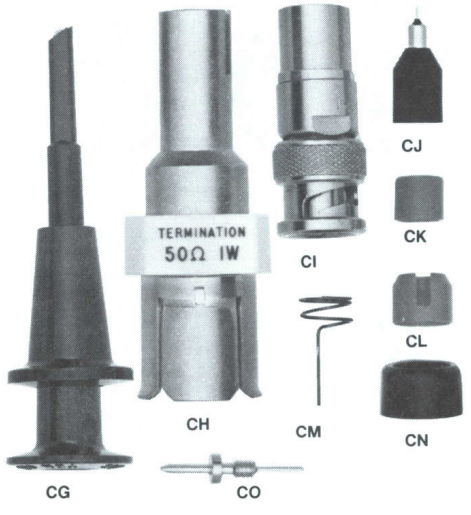

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| BA | Retractable hook tip (for all miniature probes) | 013-0105-00 | $8.50 |
| BB | Retractable hook tip (for P6053B, P6055, P6062B, P6063B, P6101A, P6105A, P6106A, P6108, P6149, P6120, P6121, and P6122) | 013-0107-05 | $3.25 |
| BC | Probe tip, IC Grabber | 013-0191-00 | $6.50 |
| BD | Miniature retractable hook tip | 206-0222-00 | $3.50 |
| BE | Probe tip flexible, adapts miniature probe to retractable hook tip (BD) | 103-0177-01 | $6.50 |
| BF | Probe tip flexible for 0.025 square pin | 206-0193-00 | $8.00 |
| BG | Miniature probe to #6-32 adaptor (for all miniature probes except P6045 and P6202) | 103-0051-01 | $4.00 |
| BH | Miniature probe to #6-32 adaptor with ground connection | 103-0131-00 | $7.75 |
| BI | Probe pin tip (accepts 0.025 in IBM SLT pin) | 206-0209-00 | $3.50 |
| BJ | Miniature probe tip to GR adaptor | 017-0076-00 | $55.00 |
| BK | Miniature probe tip to GR 50 Ω termination adaptor | 017-0088-00 | $50.00 |
| | Subminiature probe tip to GR 50 Ω termination adaptor | 017-0520-00 | $48.00 |
| BL | Chassis mount test jack (for miniature probes) | 131-0258-00 | $3.65 |
| BM | Bayonet ground assembly | 013-0085-00 | $8.50 |
| BN | Miniature probe tip cover, IC tester, Package of 10 | 015-0201-04 | $7.00 |
| | Package of 100 | 015-0201-05 | $18.00 |
| BO | Replaceable probe tip, pkg of 10. All miniature probes except P6202 and P6420 | 206-0191-03 | $17.00 |
| BP | Miniature probe tip ground cover, insulating sleeve | 166-0404-01 | $1.00 |
| BQ | Electrical contact | 214-0283-00 | $1.00 |
| BR | Termination, 50 Ω | 011-0049-01 | $25.00 |
| BS | Miniature probe tip to BNC adaptor | 013-0084-01 | $8.00 |
| | Subminiature probe tip to BNC adaptor | 013-0195-00 | $9.00 |
| BT | Miniature probe tip to BNC adaptor for all except P6202 | 013-0084-02 | $10.00 |
| BU | Miniature probe tip hook | 206-0114-00 | $2.95 |
| BV | Miniature probe tip straight | 206-0114-01 | $2.95 |
| BW | Miniature probe tip to dual lead adaptor | 015-0325-00 | $15.00 |
| BX | Subminiature retractable hook tip | 013-0208-00 | $1.75 |
| BY | Subminiature to miniature probe tip adaptor (allows use of miniature accessories with subminiature probes) | 013-0202-00 | $4.00 |
| BZ | Circuit board probe test point outer case | 131-1436-00 | $6.00 |
| | Circuit board probe test point inner connector (need to order both for one test point) | 136-0333-00 | $0.50 |
| BAA | Miniature probe tip to BNC female | 103-0096-00 | $12.75 |

## OTHER ADAPTORS




| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| CA | Retractable hook tip (for P6010 and P6048) | 013-0090-00 | $5.00 |
| CB | Retractable hook tip (for S-3A, P6202, and P6420) | 013-0097-01 | $8.50 |
| CC | Retractable hook tip (for 7A11 and P6401) | 013-0106-00 | $13.25 |
| CD | Retractable hook tip (for 211, 212, 213, 214, 221) | 013-0107-02 | $3.25 |
| CE | Miniature probe to #6-32 adaptor (for P6045, P6046, P6202, 7A11, S-3A) | 103-0051-00 | $4.00 |
| CF | Replaceable probe tip for P6202 and P6420, pkg of 10 | 206-0230-03 | $17.00 |

## P6201 ACCESSORIES




| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| CG | Retractable probe tip | 013-0135-00 | $5.25 |
| CH | P6201 probe tip to GR 50 Ω termination adaptor | 017-0094-00 | $70 |
| CI | Probe tip to BNC adaptor | 013-0145-00 | $18 |
| CJ | Probe tip to test point jack | 103-0164-00 | $7.50 |
| CK | Insulating sleeve, electrical | 166-0557-00 | $1.00 |
| CL | Ground contact insulator | 342-0180-00 | $1.00 |
| CM | Ground contact | 131-1302-00 | $1.15 |
| CN | Ground lead, insulating sleeve | 166-0433-00 | $1.00 |
| CO | Replaceable probe tip | 206-0200-00 | $1.00 |

## CABLE MARKER SETS (Not Pictured)

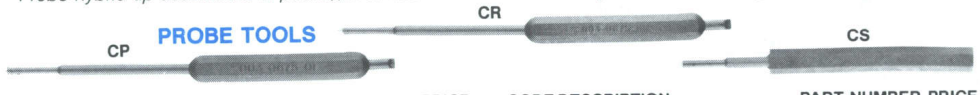
| DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|
| For 1/8 in dia cable | 016-0130-00 | $7.00 |
| For 3/16 in dia cable | 016-0127-00 | $6.00 |
| For all modular cables | 016-0633-00 | $4.00 |

## MODULAR PROBE REPLACEMENT PARTS

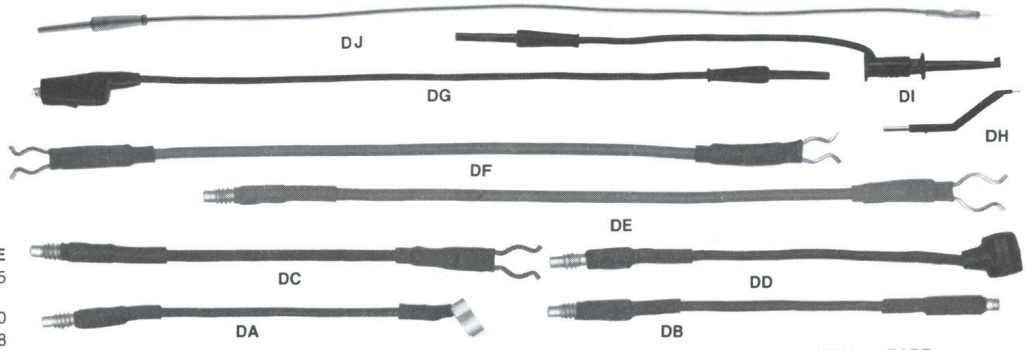
| Probe | Length (m) | Connector/Comp Box | | Probe Cable | | Probe Head | | Probe Tip/Hybrid Tip | |
|---|---|---|---|---|---|---|---|---|---|
| P6101A | 1 | 103-0189-00 | $18.50 | 175-9419-00 | $15.00 | 206-0223-02 | $22.00 | 206-0191-03*1 | $17.00 |
| | 2 | 103-0189-00 | $18.50 | 175-9409-00 | $17.00 | 206-0223-02 | $22.00 | 206-0191-03*1 | $17.00 |
| | 3 | 103-0189-00 | $18.50 | 175-9410-00 | $19.00 | 206-0223-02 | $22.00 | 206-0191-03*1 | $17.00 |
| P6102A | 2 | 206-0352-00 | $22.00 | 175-9409-00 | $17.00 | 206-0302-00 | $18.00 | 206-0338-01*2 | $25.00 |
| P6104A | 1 | 206-0332-00 | $43.00 | 175-9419-00 | $15.00 | 206-0303-00 | $17.00 | 206-0336-01*2 | $25.00 |
| P6105A | 1 | 206-0331-00 | $53.00 | 175-9419-00 | $15.00 | 206-0328-00 | $18.00 | 206-0336-01*2 | $25.00 |
| | 2 | 206-0334-00 | $53.00 | 175-9409-00 | $17.00 | 206-0301-00 | $18.00 | 206-0337-01*2 | $31.00 |
| | 3 | 206-0320-02 | $53.00 | 175-9410-00 | $19.00 | 206-0302-00 | $18.00 | 206-0338-01*2 | $25.00 |
| P6106A | 1 | 206-0313-01 | $80.00 | 175-9419-00 | $15.00 | 206-0328-00 | $18.00 | 206-0336-01*2 | $25.00 |
| | 2 | 206-0319-01 | $80.00 | 175-9409-00 | $17.00 | 206-0301-00 | $18.00 | 206-0337-01*2 | $31.00 |
| | 3 | 206-0320-01 | $80.00 | 175-9410-00 | $19.00 | 206-0302-00 | $18.00 | 206-0338-01*2 | $25.00 |
| P6107A | 2 | 206-0247-02 | $50.00 | 175-9409-00 | $17.00 | 206-0217-02 | $18.00 | 206-0339-02*2*4 | |
| P6108A | 1 | 206-0332-01 | $53.00 | 175-9419-00 | $15.00 | 206-0303-00 | $17.00 | 206-0336-01*2 | $25.00 |
| | 2 | 206-0318-02 | $45.00 | 175-9409-00 | $17.00 | 206-0304-00 | $17.00 | 206-0337-01*2 | $31.00 |
| | 3 | 206-0333-00 | $53.00 | 175-9410-00 | $19.00 | 206-0305-00 | $17.00 | 206-0338-01*2 | $25.00 |
| P6121 | 1.5 | 206-0311-00 | $50.00 | 175-9411-00 | $15.00 | 206-0323-00 | $25.00 | 206-0341-01*2 | $25.00 |
| P6122 | 1.5 | 206-0312-00 | $45.00 | 175-9411-00 | $15.00 | 206-0324-00 | $17.00 | 206-0342-01*2 | $25.00 |
| | 2 | 206-0318-00 | $45.00 | 175-9412-00 | $17.00 | 206-0325-00 | $17.00 | 206-0343-01*2 | $25.00 |
| | 3 | 206-0318-01 | $45.00 | 175-9413-00 | $19.00 | 206-0326-00 | $17.00 | 206-0344-01*2 | $25.00 |
| P6125 | 1.5 | 206-0335-00 | $45.00 | 175-9411-00 | $15.00 | 206-0256-02 | $35.00 | 206-0191-03*1 | $17.00 |
| P6130 | 1.5 | 206-0313-00 | $80.00 | 175-9415-00 | $19.00 | 206-0270-00 | $12.00 | 206-0270-00*3 | $12.00 |
| | 2 | 206-0319-00 | $80.00 | 175-9416-00 | $23.00 | 206-0270-02 | $12.00 | 206-0270-02*3 | $12.00 |
| | 3 | 206-0320-00 | $80.00 | 175-9417-00 | $27.00 | 206-0270-01 | $12.00 | 206-0270-01*3 | $12.00 |
| P6131 | 1.3 | 206-0314-00 | $85.00 | 175-9414-00 | $19.00 | 206-0265-00 | $12.00 | 206-0265-00*3 | $12.00 |
| | 2 | 206-0321-00 | $85.00 | 175-9416-00 | $23.00 | 206-0265-02 | $12.00 | 206-0265-02*3 | $12.00 |
| | 3 | 206-0322-00 | $85.00 | 175-9417-00 | $27.00 | 206-0265-01 | $12.00 | 206-0265-01*3 | $12.00 |
| P6133 | 1.3 | 206-0349-00 | $22.00 | 174-0075-00 | $19.00 | 206-0265-00 | $12.00 | 206-0265-00 | $12.00 |
| | 2 | 206-0350-00 | $22.00 | 174-0073-00 | $23.00 | 206-0265-02 | $12.00 | 206-0265-02 | $12.00 |
| | 3 | 206-0351-00 | $22.00 | 174-0074-00 | $27.00 | 206-0265-01 | $12.00 | 206-0265-01 | $12.00 |
| P6148A | 2 | 206-0288-02 | $50.00 | 175-9409-00 | $17.00 | 206-0217-02 | $18.00 | 206-0339-01*2 | $25.00 |
| P6149A | 2 | 206-0255-02 | $50.00 | 175-9409-00 | $17.00 | 206-0217-02 | $18.00 | 206-0339-01*2 | $25.00 |
| P6101 | 1 | 103-0189-00 | $18.50 | 175-1661-00 | $27.00 | 206-0223-00 | $20.00 | 206-0191-03*1 | $17.00 |
| | 2 | 103-0189-00 | $18.50 | 175-1661-01 | $27.00 | 206-0223-00 | $20.00 | 206-0191-03*1 | $17.00 |
| | 3 | 103-0189-00 | $18.50 | 175-1661-02 | $27.00 | 206-0223-00 | $20.00 | 206-0191-03*1 | $17.00 |
| P6104 | 1 | 206-0244-03 | $29.00 | 175-1661-00 | $27.00 | 206-0244-03 | $29.00 | 206-0191-03*1 | $17.00 |
| P6105 | 1 | 206-0219-02 | $48.00 | 175-1661-00 | $27.00 | 206-0216-00*4 | | 206-0191-03*1 | $17.00 |
| | 2 | 040-1164-00 | $48.00 | 175-1661-01 | $27.00 | 206-0217-00 | $48.00 | 206-0191-03*1 | $17.00 |
| | 3 | 206-0221-02 | $33.00 | 175-1661-02 | $27.00 | 206-0218-00*4 | | 206-0191-03*1 | $17.00 |
| P6106 | 1 | 206-0237-02 | $65.00 | 175-1661-00 | $27.00 | 206-0216-00*4 | | 206-0191-03*1 | $17.00 |
| | 2 | 040-1167-00 | $70.00 | 175-1661-01 | $27.00 | 206-0217-00 | $48.00 | 206-0191-03*1 | $17.00 |
| | 3 | 206-0239-02 | $70.00 | 175-1661-02 | $27.00 | 206-0218-00*4 | | 206-0191-03*1 | $17.00 |
| P6107 | 2 | 206-0247-00 | $42.00 | 175-1661-01 | $27.00 | 206-0217-00 | $48.00 | 206-0191-03*1 | $17.00 |
| P6108 | 1 | 040-1169-00 | $30.00 | 175-1661-00 | $27.00 | 206-0224-00 | $41.00 | 206-0191-03*1 | $17.00 |
| | 2 | 206-0228-03 | $44.00 | 175-1661-01 | $27.00 | 206-0225-00 | $41.00 | 206-0191-03*1 | $17.00 |
| | 3 | 206-0229-03 | $35.00 | 175-1661-02 | $27.00 | 206-0226-00 | $41.00 | 206-0191-03*1 | $17.00 |
| P6148 | 2 | 206-0288-00 | $45.00 | 175-1661-00 | $27.00 | 206-0234-00 | $38.00 | 206-0191-03*1 | $17.00 |
| P6149 | 2 | 206-0255-00 | $40.00 | 175-1661-01 | $27.00 | 206-0234-00 | $38.00 | 206-0191-03*1 | $17.00 |

*1 *Probe tips in packages of ten.*
*2 *Probe hybrid tip assemblies in packages of five.*
*3 *Probe hybrid tip assembly in quantities of one.*
*4 *Contact your local sales engineer for information.*

## PROBE TOOLS



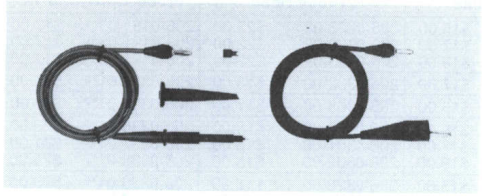

| CODE | DESCRIPTION | PART NUMBER | PRICE |
|---|---|---|---|
| CP | Adjustment tool, probe (0.025 inch square end) (For P6202A only) | 003-0675-01 | $1.55 |
| CQ | Probe tip extractor | 003-0825-00 | $1.65 |
| CR | Adjustment tool, probe (blade end) (For P6055 only) | 003-1364-00 | $2.90 |
| CS | Adjustment tool, probe (blade end) (General purpose) | 003-0675-00 | $0.75 |




| CODE | DESCRIPTION | LENGTH (in) | PART NUMBER | PRICE |
|---|---|---|---|---|
| DA | Ground lead for S-3A, P6056, P6057 | 3 | 175-0249-00 | $5.00 |
| DB | Ground leads for P6054, P6075 | 3 | 175-0848-00 | $2.80 |
| | 7A11, and P6201 | 5 | 175-0848-01 | $1.75 |
| | | 12 | 175-0848-02 | $2.00 |
| DC | Ground leads for P6202 and P6420 | 3 | 175-0849-00 | $6.00 |
| | | 6 | 175-0849-01 | $6.00 |
| DD | Ground lead*1 | 3 | 175-0263-01 | $2.30 |
| | Ground lead*1 | 5 | 175-0124-01 | $2.30 |
| | Ground lead*1 | 12 | 175-0125-01 | $2.30 |
| DE | Ground leads for S-3A, P6202, P6420 | 6 | 175-1017-00 | $3.50 |
| DF | Ground lead for P6055 | 6 | 175-1256-00 | $5.00 |
| DG | Alligator clip for P6230, P6120, P6130 families | | 195-1870-00 | $6.75 |
| DH | Subminiature Low Impedance for P6230, P6130 families | | 195-4240-00 | $2.75 |
| DI | Microhook for P6230, P6120, P6130 families | | 195-4104-00 | $8.75 |
| DJ | Ground lead for P6230, P6120, P6130 families | | 195-1870-01 | $6.25 |

*1 *For the P6053B, P6054A, P6075A, P6101A, P6105A, P6106A, P6108A, P6149A, and other probes requiring clip-on ground leads.*

## TEST LEADS



| | | |
|---|---|---|
| Test Lead, Black, 4 ft | 012-0425-00 | $12.00 |
| Test Lead, Red, 4 ft | 012-0426-00 | $22.00 |
| Test Lead, Black, 4 ft | 012-0426-01 | $22.00 |
| Test Lead set includes 012-0425-00, 012-0426-00,and 013-0107-05 | 012-0427-00 | $29.00 |

## LOGIC PROBE TEST LEADS

| | | |
|---|---|---|
| 16 pin low profile dip clip (can be used with 14 or 16 pin ICs) | 015-0330-00 | $40.00 |
| 10 wide comb set (grabber tips not included) | 012-0747-00 | $50.00 |

## PERSONALITY MODULE TEST LEADS

| | | |
|---|---|---|
| 40 Pin Dip Clip—10 cm cable (order M/F adaptor below) | 015-0339-00 | $44.00 |
| 40 Pin Dip Clip—30 cm cable Male Adaptor for 40 Pin (order M/F adaptor below) | 015-0339-02 | $44.00 |
| Male Adaptor for 40 Pin Low Profile Dip Clip | 380-0560-05 | $15.00 |
| Female Adaptor for 40 Pin Low Profile Dip Clip | 380-0647-01 | $36.00 |

## KLIPKIT

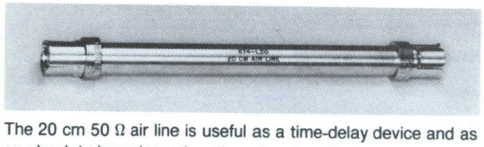
The P6130, P6131 and P6230 are used directly, other probes must use the supplied pins and attach via a retractable hook tip. Up to 16 pin DIP can be connected. Four supplied pins make signals accessible at the top of the KLIPKIT, or invert the pins for pin signal connection to a common connection strap inside the clip, Two IC clips, 4 signal ground pins and information sheet included.

| | | |
|---|---|---|
| Klipkit | 013-0197-00 | $40.00 |

## IC CLIP

| | | |
|---|---|---|
| 16 pin dip, clothes pin style | 003-0709-00 | $11.75 |
| 24 pin dip, clothes pin style | 003-0823-00 | $30.00 |
| 40 pin dip, clothes pin style | 003-0801-00 | $43.00 |

## 50 Ω AIR LINE

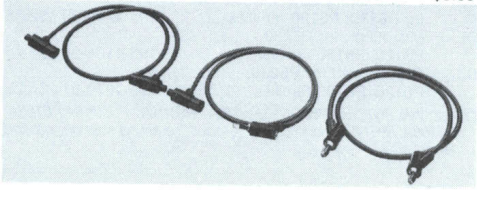


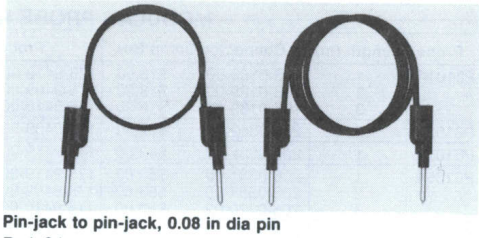
The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

| | | |
|---|---|---|
| 50 Ω Air Line | 017-0084-00 | $165.00 |

## PATCH CORDS

| | | |
|---|---|---|
| **BNC to BNC, 18 in** | | |
| Red | 012-0087-00 | $7.00 |
| Black | 012-0086-00 | $7.00 |
| **BNC to banana plug-jack, 18 in** | | |
| Red | 012-0091-00 | $7.00 |
| Black | 012-0090-00 | $7.00 |
| **Banana plug-jack to banana plug-jack, 18 in** | | |
| Red | 012-0031-00 | $7.00 |
| Black | 012-0039-00 | $8.00 |





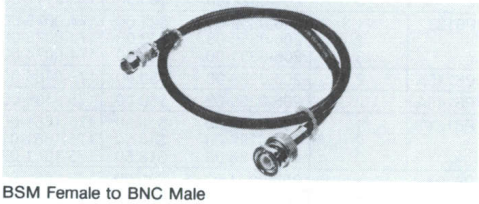
**Pin-jack to pin-jack, 0.08 in dia pin**

| | | |
|---|---|---|
| Red, 8 in | 012-0179-00 | $4.00 |
| Red, 18 in | 012-0180-00 | $3.75 |
| Black, 8 in | 012-0181-00 | $3.75 |
| Black, 18 in | 012-0182-00 | $4.25 |

## COAXIAL CABLES BNC

| | | |
|---|---|---|
| Coaxial, 50 Ω, 42 in | 012-0057-01 | $17.00 |
| Coaxial, 75 Ω, 42 in | 012-0074-00 | $17.50 |
| Coaxial, 93 Ω, 42 in | 012-0075-00 | $29.00 |
| Coaxial, 50 Ω, 18 in | 012-0076-00 | $17.00 |
| Coaxial, 50 Ω, 18 in, Male to Female | 012-0104-00 | $25.00 |
| Coaxial, 50 Ω ±1% Precision, 36 in | 012-0482-00 | $25.00 |

## BSM



| | | |
|---|---|---|
| BSM Female to BNC Male Coaxial, 10 in, RG58 | 012-0128-00 | $20.00 |
| BSM Female to BNC Male Coaxial, 18 in, RG58 | 012-0127-00 | $23.00 |

## GR 50 Ω

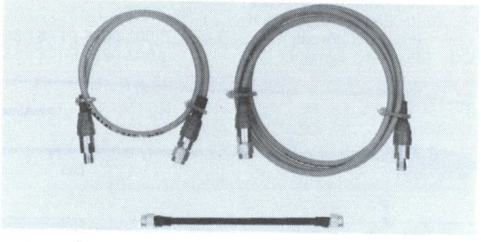
| | | |
|---|---|---|
| Coaxial 10 ns RG58A/U | 017-0501-00 | $85.00 |
| Coaxial 5 ns RG213/U | 017-0502-00 | $175.00 |
| Coaxial 1 ns RG58A/U*[1] | 017-0503-00 | $100.00 |
| Coaxial 2 ns RG58A/U | 017-0505-00 | $120.00 |
| Coaxial 5 ns RG58A/U | 017-0512-00 | $90.00 |
| Coaxial 10 in RG213/U | 017-0513-00 | $80.00 |
| Coaxial 20 in RG213/U | 017-0515-00 | $95.00 |

*[1] *Connector on one end only.*

## N 50 Ω

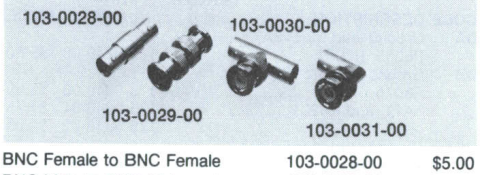
| | | |
|---|---|---|
| Coaxial N Connectors, 6 ft | 012-0114-00 | $25.00 |

## SMA (3 mm) 50 Ω



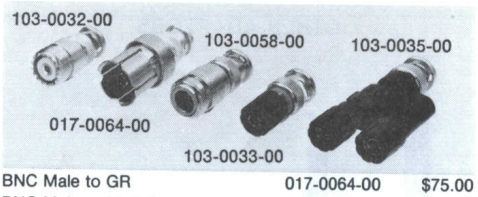
| | | |
|---|---|---|
| Coaxial, 2 ns, Male to Female | 015-1005-00 | $90.00 |
| Coaxial, 5 ns, Male to Female | 015-1006-00 | $140.00 |
| Coaxial semirigid 500 ps, 4.5 in male only | 015-1015-00 | $25.00 |
| Coaxial semirigid 750 ps, | 015-1017-00 | $35.00 |
| Coaxial, 1 ns | 015-1019-00 | $120.00 |

## ADAPTORS

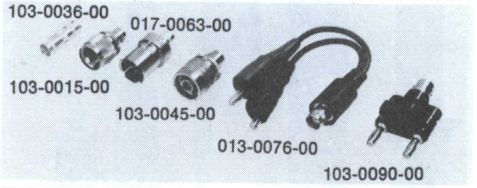



| | | |
|---|---|---|
| BNC Female to BNC Female | 103-0028-00 | $5.00 |
| BNC Male to BNC Male | 103-0029-00 | $5.50 |
| BNC T | 103-0030-00 | $8.00 |
| BNC Elbow Male to Female | 103-0031-00 | $7.50 |

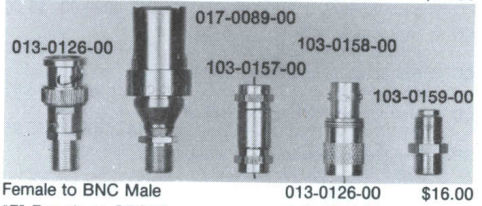
**Minimum acceptable order is $25.00.**



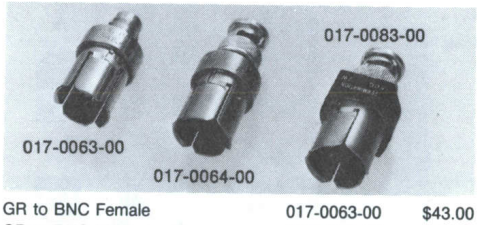

| | | |
|---|---|---|
| BNC Male to GR | 017-0064-00 | $75.00 |
| BNC Male to UHF Female | 103-0032-00 | $5.00 |
| BNC Male to Binding Post | 103-0033-00 | $5.00 |
| BNC Male to Dual Binding Post | 103-0035-00 | $12.00 |
| BNC Male to N Female | 103-0058-00 | $7.00 |



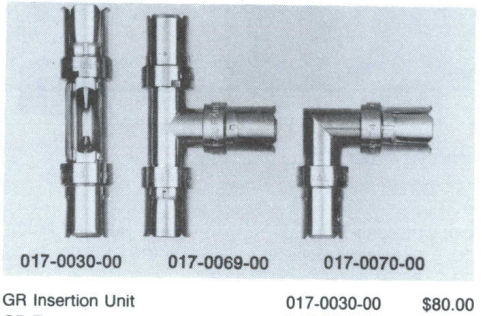

| | | |
|---|---|---|
| BNC Female to clip leads | 013-0076-00 | $25.00 |
| BNC Female to GR | 017-0063-00 | $43.00 |
| BNC Female to UHF Male | 103-0015-00 | $4.50 |
| BNC Female to BSM Male | 103-0036-00 | $15.00 |
| BNC Female to N Male | 103-0045-00 | $6.50 |
| BNC Female to Dual Banana | 103-0090-00 | $7.50 |
| BNC Female to EZ Ball | 013-0076-01 | $17.50 |



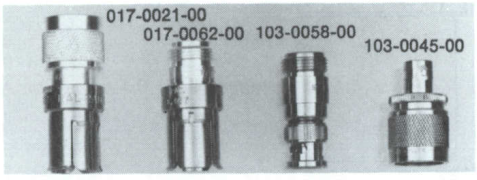

| | | |
|---|---|---|
| Female to BNC Male | 013-0126-00 | $16.00 |
| "F" Female to GR874 | 017-0089-00 | $50.00 |
| "F" Male to "F" Male | 103-0157-00 | $7.50 |
| "F" Male to BNC Female | 103-0158-00 | $11.00 |
| "F" Female to "F" Female | 103-0159-00 | $7.50 |



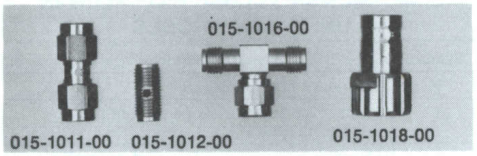

| | | |
|---|---|---|
| GR to BNC Female | 017-0063-00 | $43.00 |
| GR to BNC Male | 017-0064-00 | $75.00 |
| 50 Ω termination, thru-line (GR to BNC Male) | 017-0083-00 | $85.00 |




| | | |
|---|---|---|
| GR Insertion Unit | 017-0030-00 | $80.00 |
| GR T | 017-0069-00 | $110.00 |
| GR Elbow | 017-0070-00 | $120.00 |

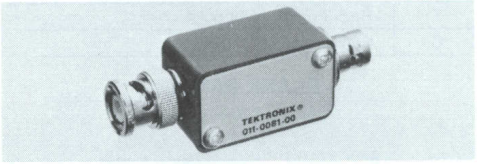



| | | |
|---|---|---|
| N Male to GR | 017-0021-00 | $50.00 |
| N Female to GR | 017-0062-00 | $55.00 |
| N Male to BNC Female | 103-0045-00 | $6.50 |
| N Female to BNC Male | 103-0058-00 | $7.00 |




| | | |
|---|---|---|
| SMA Male to Male | 015-1011-00 | $20.00 |
| SMA Female to Female | 015-1012-00 | $9.25 |
| SMA T | 015-1016-00 | $35.00 |
| SMA Male to BNC Female | 015-1018-00 | $8.00 |

## ACCESSORY HOUSING




Accessory housing without electrical components is useful for applications requiring special circuitry.

| | | |
|---|---|---|
| Accessory Housing | 011-0081-00 | $30.00 |

## ATTENUATORS—TERMINATIONS

**BNC**

| | | |
|---|---|---|
| 50 Ω ±0.1% precision feed-through termination (dc −100 kHz, 11 V RMS maximum) | 011-0129-00 | $95.00 |
| 50 Ω feed through termination*1 | 011-0049-01 | $25.00 |
| 50 Ω 10X (20 dB) attenuator*2 | 011-0059-02 | $35.00 |
| 50 Ω 5X (14 dB) attenuator*2 | 011-0060-02 | $35.00 |
| 50 Ω (6 dB) attenuator*2 | 011-0069-02 | $35.00 |
| 50 Ω 2.5X (8 dB) attenuator*2 | 011-0076-02 | $35.00 |
| 50 Ω feedthrough termination (5 W)*3 | 011-0099-00 | $40.00 |

**vswr**

*1 *<1.1 dc −250 MHz and <1.2 dc −500 MHz.*

*2 *<1.1 dc −1.0 GHz and <1.2 dc −2.0 GHz.*

*3 *1.1 dc −100 MHz.*

**Characteristics** — Dc resistance is 50 Ω ±1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

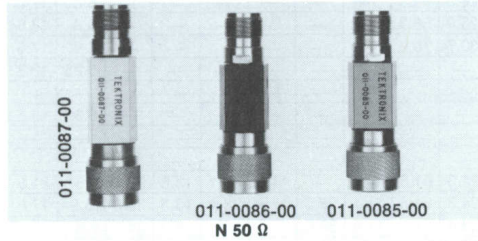
| | | |
|---|---|---|
| 75 Ω feedthrough termination | 011-0055-01 | $25.00 |
| 93 Ω feedthrough termination | 011-0056-01 | $25.00 |
| 50 Ω to 75 Ω minimum loss attenuator | 011-0057-01 | $30.00 |
| 50 Ω to 93 Ω minimum loss attenuator | 011-0058-01 | $30.00 |
| 75 Ω 10X attenuator | 011-0061-00 | $32.00 |
| 93 Ω 10X attenuator | 011-0062-00 | $30.00 |
| 600 Ω feedthrough termination (1 W, dc to 1 MHz) | 011-0092-00 | $30.00 |
| 75 Ω to 50 Ω minimum loss attenuator (ac coupled) | 011-0112-00 | $60.00 |

**Characteristics** — Accuracy of indicated attenuation ratio is ±2% at dc. Power rating of attenuators is ½ W and terminations 1 W. Voltage standing wave ratio (vswr) not specified.

**GR 50 Ω**

| | | |
|---|---|---|
| 50 Ω 10X attenuator | 017-0078-00 | $275.00 |
| 50 Ω 5X attenuator | 017-0079-00 | $240.00 |
| 50 Ω 2X attenuator | 017-0080-00 | $190.00 |
| 50 Ω termination, end-line | 017-0081-00 | $135.00 |

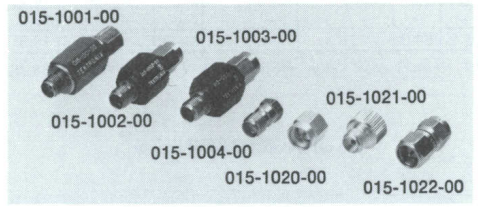
**Characteristics** — Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (vswr) is <1.1 up to 1 GHz. Power rating is 1 W.




**N 50 Ω**

| | | |
|---|---|---|
| 10 dB attenuator | 011-0085-00 | $70.00 |
| 20 dB attenuator | 011-0086-00 | $70.00 |
| 40 dB attenuator | 011-0087-00 | $90.00 |

**Characteristics** — Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω ±1.0 dB.



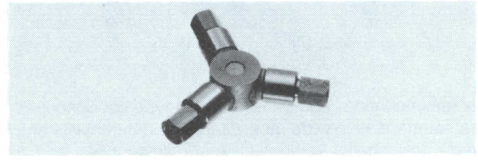

**SMA (3 mm) 50 Ω**

| | | |
|---|---|---|
| 50 Ω 2X attenuator | 015-1001-00 | $120.00 |
| 50 Ω 5X attenuator | 015-1002-00 | $120.00 |
| 50 Ω 10X attenuator | 015-1003-00 | $120.00 |
| 50 Ω termination Female | 015-1004-00 | $60.00 |
| Short-Circuit termination Male | 015-1020-00 | $17.50 |
| Short-Circuit termination Female | 015-1021-00 | $24.00 |
| 50 Ω termination Male | 015-1022-00 | $32.00 |

**Characteristics**

| | Dc—12.40 GHz Attenuation | | 12.41—18.00 GHz Attenuation | | Power |
|---|---|---|---|---|---|
| | Accuracy | Vswr | Accuracy | Vswr | Continuous |
| Termination | ±1 Ω | 1.15 | ±1 Ω | 1.15 | 0.5 W |
| 2X (6 dB) | ±0.75 dB | 1.40 | ±1.00 dB | 2.00 | 1.0 W |
| 5X (14 dB) | ±0.75 dB | 1.40 | ±1.00 dB | 1.60 | 1.0 W |
| 10X (20 dB) | ±0.75 dB | 1.40 | ±1.00 dB | 1.60 | 1.0 W |

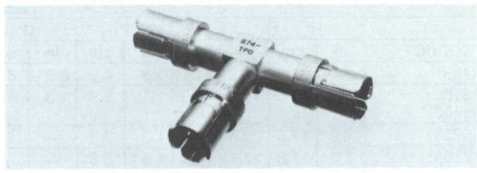
## 50 Ω POWER DIVIDERS



This coaxial tee is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Maximum vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

| | | |
|---|---|---|
| Power Divider SMA (3 mm) | 015-1014-00 | $200.00 |

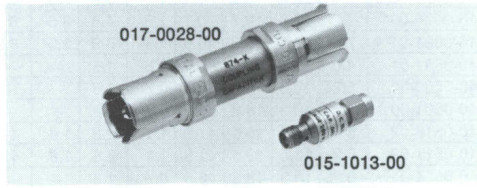
**Minimum acceptable order is $25.00.**



This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

| | | |
|---|---|---|
| Power Divider GR | 017-0082-00 | $375.00 |

## 50 Ω COUPLING CAPACITOR

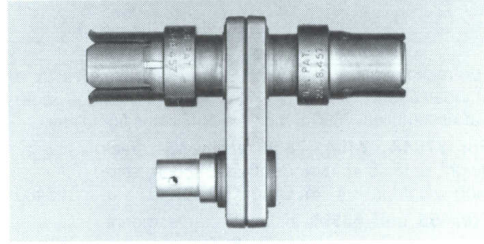



The coupling capacitor is a short length of coaxial line with a disk capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150 ps tdr system), is 0.03 maximum. Voltage rating is 200 V.

| | | |
|---|---|---|
| Coupling Capacitor SMA (3 mm) | 015-1013-00 | $200.00 |

The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

| | | |
|---|---|---|
| Coupling Capacitor GR | 017-0028-00 | $100.00 |



## CT-3 Signal Pickoff

Design for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

**Sensitivity** — 10% of the voltage under test, into a 50 Ω load.
**Decay Time Constant** — 4.5 μs at 0 dc current.
**Risetime** — <0.4 ns.
**Frequency Response** — 50 kHz to 875 MHz at 0 dc current.
**Insertion Impedance** — With 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 M termination.
**Vswr** — <1.2 at 1.5 GHz.
**Voltage Rating** — At 0 V dc is 25 V RMS. 1 kV pulse peak. The V's product is 100 V μs. If exceeded, the L/R decay will decay rapidly toward zero.

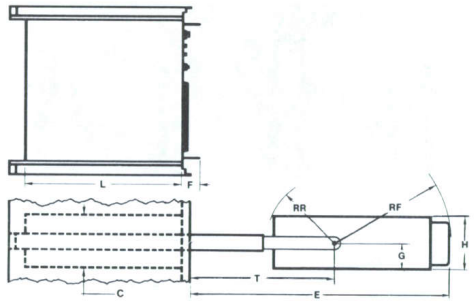
**ORDERING INFORMATION**

**CT-3** Signal Pickoff
Order 017-0061-00 **$170.00**

## MOUNTING DIMENSIONS

| PRODUCT | H | | L | | F | | G | | E | | RF | | RR | | T | | C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm | in | cm |
| R485*[1] | 7.0 | 17.8 | 16.2 | 41.1 | 1.8 | 4.6 | 3.5 | 8.9 | 19.3 | 49.0 | 10.9 | 27.7 | 7.9 | 20.1 | 9.3 | 23.6 | 6.8 | 17.3 |
| R5100<br>R5400*[1] | 5.3 | 13.5 | 19.0 | 48.3 | 1.1 | 2.8 | 1.8 | 4.6 | 24.6 | 62.5 | — | — | — | — | — | — | 5.3 | 13.5 |
| R5223 | 7.0 | 17.8 | 20.8 | 52.9 | 1.3 | 3.3 | — | — | — | — | — | — | — | — | — | — | 7.0 | 17.8 |
| R7103 | 7.0 | 17.8 | 27.7 | 70.4 | 1.5 | 3.8 | — | — | 29.0 | 73.7 | — | — | — | — | — | — | 7.0 | 17.8 |
| R7704*[1] | 7.0 | 17.8 | 22.4 | 56.9 | 2.3 | 5.8 | 1.8 | 4.6 | 33.3 | 84.6 | 15.3 | 38.9 | 10.7 | 27.2 | 18.5 | 47.0 | 7.0 | 17.8 |
| R7313*[1]<br>R7603*[1]<br>R7613*[1]<br>R7623*[1] | 5.3 | 13.5 | 22.3 | 56.6 | 2.0 | 5.1 | — | — | 25.2 | 64.0 | — | — | — | — | — | — | 5.3 | 13.5 |
| R7844*[1] | 7.0 | 17.8 | 24.8 | 63.0 | 2.3 | 5.8 | 1.75 | 4.4 | — | — | — | — | — | — | — | — | 7.0 | 17.8 |
| R7903*[1] | 5.3 | 13.5 | 22.8 | 57.9 | 2.3 | 5.8 | — | — | 25.3 | 64.3 | — | — | — | — | — | — | 5.3 | 17.8 |
| R7912*[1] | 5.3 | 13.5 | 26.9 | 68.3 | 1.8 | 4.6 | — | — | 26.9 | 68.3 | — | — | — | — | — | — | 5.3 | 13.5 |
| 7912AD | 7.0 | 17.8 | 26.0 | 66.0 | 1.95 | 5.0 | — | — | 30.7 | 78.0 | — | — | — | — | — | — | 6.9 | 17.5 |
| RTM506 | 5.25 | 13.3 | 18.9 | 48.0 | 1.82 | 4.7 | — | — | — | — | — | — | — | — | — | — | 5.25 | 13.3 |
| 016-0015-00 | 5.1 | 13.0 | 16.3 | 41.4 | 1.8 | 4.5 | — | — | — | — | — | — | — | — | — | — | — | — |
| 016-0115-05 | 5.3 | 13.5 | 16.3 | 41.4 | 0.3 | 0.8 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| 016-0466-00 | 5.1 | 13.0 | 16.3 | 41.4 | 1.8 | 4.5 | — | — | — | — | — | — | — | — | — | — | — | — |
| 016-0468-00 | 5.2 | 13.3 | 14.9 | 37.8 | 2.0 | 5.1 | — | — | — | — | — | — | — | — | — | — | — | — |
| 016-0675-00*[1] | 8.8 | 22.4 | 19.7 | 50.1 | 1.5 | 3.9 | 3.5 | 8.9 | 24.3 | 61.6 | — | — | 11.9 | 30.1 | 13.3 | 33.8 | 8.5 | 21.6 |
| 016-0676-00*[1] | 7.0 | 17.8 | 19.7 | 50.1 | 1.9 | 4.8 | 3.5 | 8.9 | 24.3 | 61.6 | 11.1 | 28.2 | 11.2 | 28.4 | 13.3 | 33.8 | 6.9 | 17.5 |
| 016-0691-01*[1] | 7.0 | 17.8 | 18.3 | 46.5 | 1.5 | 3.9 | 3.5 | 8.9 | 20.4 | 51.9 | 11.8 | 30.0 | — | — | 9.5 | 24.1 | 6.6 | 16.7 |
| 040-0551-01 | 14.0 | 35.6 | 22.4 | 56.9 | 0.6 | 1.5 | — | — | 30.9 | 78.5 | — | — | — | — | — | — | — | — |
| 040-0600-00 | 5.25 | 13.3 | 18.3 | 46.5 | 0.7 | 1.8 | — | — | — | — | — | — | — | — | — | — | 5.25 | 13.3 |
| 040-0601-00 | 5.25 | 13.3 | 18.3 | 46.5 | 0.7 | 1.8 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| 040-0616-02 | 5.3 | 13.5 | 16.5 | 41.9 | 1.1 | 2.8 | 1.8 | 4.6 | 24.6 | 62.5 | — | — | — | — | — | — | 5.25 | 13.3 |
| 040-0617-02 | 5.3 | 13.5 | 16.5 | 41.9 | 1.1 | 2.8 | 1.8 | 4.6 | 24.6 | 62.5 | — | — | — | — | — | — | 5.3 | 13.5 |
| 040-0624-01 | 5.25 | 13.3 | 18.3 | 46.5 | 0.7 | 1.8 | — | — | — | — | — | — | — | — | — | — | 5.3 | 13.5 |
| 437-0031-00 | 8.8 | 22.4 | 9.5 | 24.1 | 0.3 | 0.8 | — | — | — | — | — | — | — | — | — | — | 5.25 | 13.3 |
| 437-0071-00 | 7.0 | 17.8 | 13.4 | 34.0 | 1.4 | 3.6 | — | — | — | — | — | — | — | — | — | — | 7.1 | 18.0 |
| 437-0126-03 | 5.3 | 13.5 | 22.3 | 56.6 | 2.0 | 5.1 | — | — | 25.2 | 64.0 | — | — | — | — | — | — | 6.6 | 16.8 |

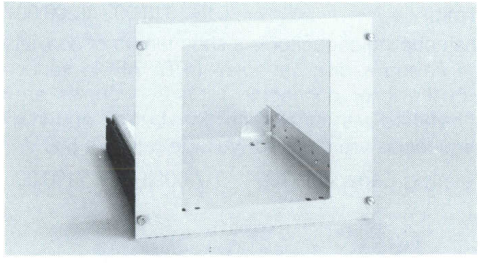
*[1] *These instruments mount with sliding tracks to a standard 19-inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.*




### DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

| Symbol | Definition |
|---|---|
| H | Height of front panel |
| L | Rack front to rearmost permanent fixture excluding cables |
| F | Back of front panel to foremost protrusion |
| G | Bottom of front panel to horizontal plane of rotation |
| E | Maximum forward clearance with instrument out and horizontal |
| RF | Front radius of rotation |
| RR | Rear radius of rotation |
| T | Rack front to pivot point |
| C | Cabinet height |

## RACK ADAPTORS



For rackmounting the 7000 Series oscilloscopes in a standard 19 in wide rack. Rack adaptor includes slide-out assemblies. 7000 Series mask finish is light gray.

**For 7704A, 7104, 7834 and 7854,** rack height is 15.75 in, rack depth is 21.38 in, shipping weight is ≈41 lb. Order 040-0611-01 $480

**For 455 and 465M,** includes cradle mount, rack height 7 in, rack depth 18.75 in. Order 040-0825-01 $535

**For 2445 and 2465.** Order 016-0691-01 $350

**For 2335.** Order 016-0468-00 $310

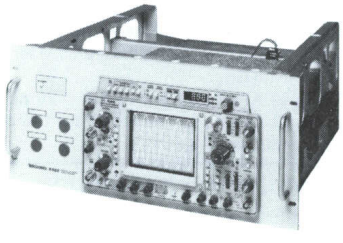
**For 2213A, 2215A and 2235.** Oder 016-0466-00 $110

**For 2236.** Order 016-0015-00 $230

**For 464 and 466.** Order 016-0676-00 $430

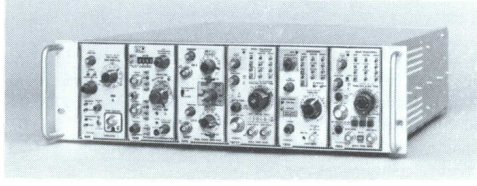
**For 485.** Order 016-0558-00 $470

**For 434.** Order 016-0272-00 $300



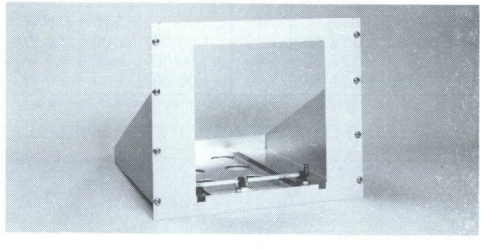
**For 468.** Order 016-0675-00 $435

## STORAGE CABINETS



**For 7000 Series Plug-in Units —** Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high. Order 437-0126-03 $825

## CRADLE MOUNTS

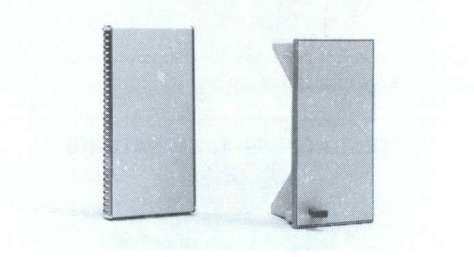


For rackmounting 7000 Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 7000 Series mask finish is light gray.

**For 7704A,** rack height is 15.75 in, rack depth is 22 in, shipping weight is ≈16 lb. Order 040-0560-00 $445

**Minimum acceptable order is $25.00.**

## BLANK PANEL



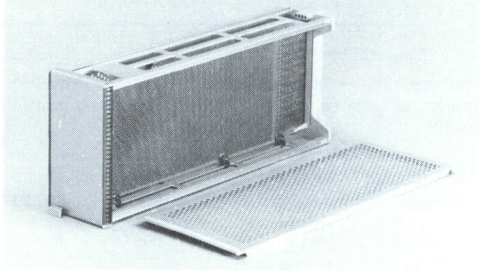
**Blank Panel —** When operating the 5000/7000 Series mainframes or the TM 500 or TM 5000 Series mainframes with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

**7000 Series.** Order 016-0155-00 $50

**5000 Series.** Order 016-0452-00 $21

**TM 500/TM 5000 Series.** Order 016-0195-03 $25

## BLANK PLUG-IN CHASSIS



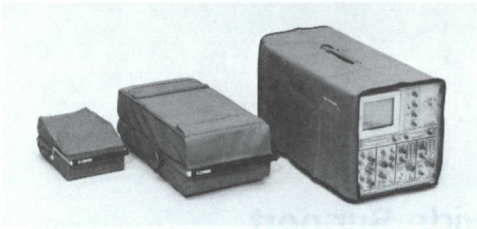
**Blank Plug-in Chassis —** Available for all Tektronix mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

**7000 Series.** Order 040-0553-03 $145

**5000 Series.** Order 040-0818-03 $105

**TM 500 Series.** Order 040-0652-05 $95

**560 Series.** Order 040-0245-00 $150



## OSCILLOSCOPE PROTECTIVE COVERS

The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000 Series laboratory oscilloscopes have clear vinyl frontal areas.

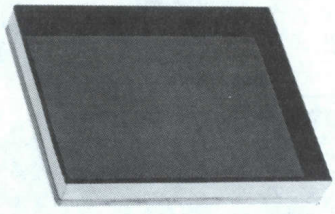
### PROTECTIVE COVERS

| INSTRUMENT | PART NUMBER | PRICE |
|---|---|---|
| 200 Series | 016-0512-00 | $17.25 |
| 323,324,1401A,1401A-1, 1501 | 016-0112-00 | $8.75 |
| 314,335 | 016-0612-00 | $65.00 |
| 326 | 016-0532-00 | $49.00 |
| 453A,454A,491 | 016-0074-01 | $18.00 |
| 434,464,466 | 016-0365-00 | $25.00 |
| 465,465B,475,485 | 016-0554-00 | $19.25 |
| 5000 Series | 016-0544-00 | $18.00 |
| 7300,7400,7600 Series | 016-0192-01 | $20.00 |
| 7704A,7900 | 016-0531-00 | $15.00 |

## PLUG-IN UNIT CARRYING CASES

**3-Wide Carrying Case** for 7L14, 7L5 Option 25, 7D20, 7L18. Order 016-0626-00 $350

**2-Wide Carrying Case** for 7L12, 7L5. Order 016-0625-00 $315



## CRT MESH FILTERS

The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

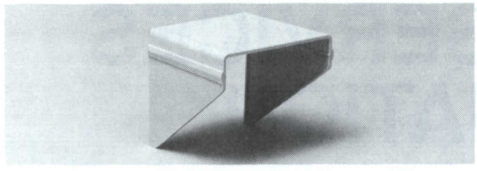
The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

| INSTRUMENT*[1] | PART NUMBER | PRICE |
|---|---|---|
| 314, 326, 335 | 378-0063-00 | $23.00 |
| 432, 434 | 378-0682-00 | $55.00 |
| 422, 491, 453A, 454A, 485 | 378-0648-00 | $34.00 |
| 465, 465B, 475, 464, 466, 434 | 378-0726-01 | $75.00 |
| 7400, 7603 | 378-0696-00 | $65.00 |
| 7100, 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 | 378-0603-00 | $65.00 |

*[1] *For both cabinet and rackmount instruments.*

## VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix sales engineer for bezel-viewer compatibility before ordering.

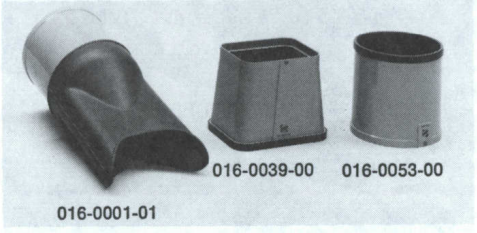


**View Hood (Folding) —**

**For 576.** Order 016-0259-00 $25

**For 577, 5000, and 7000 Series.** Order 016-0260-00 $25

**For 326, 314, 335, SC 502, SC 503, SC 504** (not pictured). Order 016-0297-00 $2.10

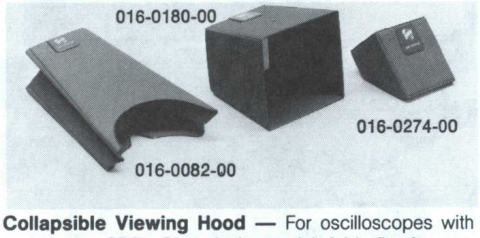



**Polarized Viewers —** For Tektronix older 5 inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

**Rectangular Viewer.** Order 016-0039-00 $85

**Plastic Round Viewer.** Order 016-0053-00 $42

**Viewing Hood —** For Tektronix older 5 inch round oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 $175




**Collapsible Viewing Hood —** For oscilloscopes with rectangular CRTs. Blue vinyl material, folds flat for convenient storage.

**For 422, 453A, 454A, 485, 491.** Order 016-0082-00 $18

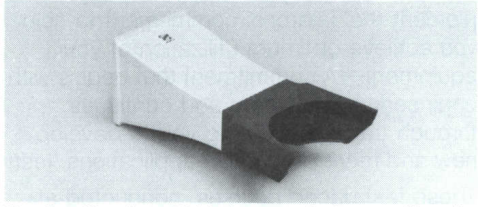
**For 422, 453A, 454A, 485, 491.** Order 016-0274-00 $18

**For 464, 466, 455, 465, 465B, 475, 2200 Series, 2445, 2465.** Order 016-0592-00 $13

**Folding Binocular Viewing Hood — For 434, 455, 464, 466, 465B, 475, 475A, and 2200 Series.** Order 016-0566-00 $18.50

**Polarized Collapsible Viewing Hood —** To reduce reflections and glare under high ambient light conditions.

**For 432, 434, 455, 465, 465B, 475, 464, 466, 2445, 2465.** Order 016-0180-00 $48



**Viewing Hood —** Molded gray polystyrene with polyurethane eyepiece.

**For 576.** Order 016-0153-00 $50

**For 5000 and 7000 Series, 601, 602, 603, 604, 528 and 577.** Order 016-0154-00 $40

## CATHODE RAY TUBE LIGHT FILTERS

| INSTRUMENT*[1] | COLOR | PART NUMBER | PRICE |
|---|---|---|---|
| 200 Series | Blue | 378-0691-00 | $1.50 |
| 314, 335 | Blue | 378-2016-01 | $1.70 |
| 434 | Blue | 378-0678-01 | $2.25 |
| 455, 465M | Blue | 337-2122-00 | $5.75 |
| 465, 465B, 475, 464, 466 | Blue | 337-1674-00 | $6.00 |
| | Clear | 337-1674-01 | $5.75 |
| | Smoke-gray filter | 337-1674-07 | $5.75 |
| 540, 550 Series 565, 575 | Smoke-gray† | 378-0567-00 | $9.00 |
| | Green | 378-0568-00 | $5.75 |
| | Blue | 378-0569-00 | $5.75 |
| | Amber | 378-0570-00 | $5.75 |
| 576 | Blue† | 378-0616-00 | $5.75 |
| 603, 604 | Clear (603†) | 337-1440-00 | $3.00 |
| | Green | 337-1440-01 | $3.00 |
| | Amber | 337-1440-02 | $3.50 |
| | Blue | 337-1440-03 | $3.50 |
| | Gray | 337-1440-04 | $4.50 |
| | Graticule (8x10 div) | 331-0303-00 | $15.00 |
| 605, 606, 607 | Blue | 337-1674-00 | $6.00 |
| | Graticule | 337-1674-10 | $10.00 |
| | Clear Shield | 337-1674-13 | $11.50 |
| | Gray† | 337-1674-06 | $5.00 |
| | Graticule (8x10 div) | 331-0391-00 | $9.00 |
| 608 | Amber | 378-0704-00 | $10.00 |
| | Graticule† | 337-2126-02 | $10.00 |
| 2200 Series | Blue† | 337-2775-00 | $3.40 |
| | Clear TV Graticule | 337-2775-01 | $1.75 |
| 2300 Series | Blue Implosion Shield† | 337-2760-00 | $1.65 |
| | Clear Implosion Shield† | 337-2781-00 | $4.40 |
| 2400 Series | Blue† | 378-0199-03 | $2.25 |
| | Clear Implosion Shield† | 378-0208-00 | $1.50 |
| 5100 and 5400 Series (except 5441) | Clear | 337-1440-00 | $3.00 |
| | Green | 337-1440-01 | $3.00 |
| | Amber | 337-1440-02 | $3.50 |
| | Blue | 337-1440-03 | $3.50 |
| | Gray | 337-1440-04 | $4.50 |
| 5441 | Clear† | 337-1674-01 | $5.75 |
| | Gray | 337-1674-06 | $5.00 |
| | Graticule (8x10 div) | 331-0391-00 | $9.00 |
| 7603 | Blue | 378-0684-00 | $7.00 |
| | Amber | 378-0684-01 | $7.00 |
| | Gray | 378-0684-02 | $7.00 |
| | Green | 378-0684-03 | $5.00 |
| | Spectrum Analyzer Graticule | 337-1439-01 | $8.50 |
| | Blue Implosion Shield† | 337-1700-01 | $5.50 |
| | Clear Implosion Shield | 337-1700-04 | $5.50 |
| 7613, 7623 7623A, 7633 | Spectrum Analyzer Graticule | 378-0625-07 | $14.50 |
| | Green (UV) | 378-0625-08 | $5.00 |
| 7844, 7313 7700 Series 7613, 7623 7100 Series 7900 Series | Blue† | 378-0625-00 | $5.75 |
| | Amber | 378-0625-01 | $5.00 |
| | Gray | 378-0625-02 | $5.00 |
| | Green | 378-0625-03 | $5.00 |
| | Gray TV Graticule NTSC Clear Shield | 378-0625-06 | $12.00 |
| | Spectrum Analyzer Graticule | 337-1159-02 | $8.50 |

*[1] *For both cabinet and rackmount instruments unless rackmount version is listed.*

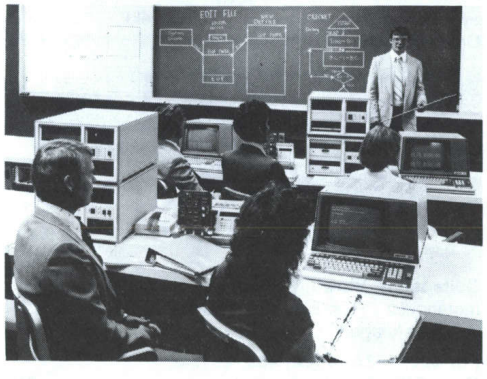
† *Standard filter supplied with instrument.*

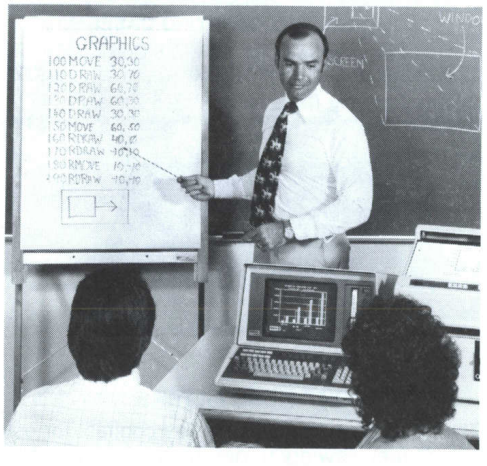
# CUSTOMER SERVICES AND INFORMATION

## Tektronix Means . . . Fast, Flexible Worldwide Support

## CONTENTS


Sales Information and Assistance ..... 452
User Assistance ..... 452
Product Characteristics ..... 453
Terms of Sale ..... 453
Warranty Statement ..... 454
Worldwide Service Support ..... 455-456
Warranty-Plus Service Plans ..... 457-458
OEM Information ..... 459
Highlights of the Past 40 Years ..... 460
Sales and Service Offices .... Inside Back Cover






### The people behind the product are friendly and ready to help you.

**Get sales information and assistance to evaluate and order the products you want.**
Ask for a Customer Service Representative the first time you contact Tektronix. The CSR can give you information on products and the names of the Sales Engineers assigned to serve your product interests. Tektronix Sales Engineers will respond to your technical and business inquiries.

Sales Engineers can give you information on dozens of products, so that you can select the one model best suited to your present and future applications, and will be happy to arrange a demonstration of that product.

Your Customer Service Representative or Sales Engineer can provide you with information on prices, terms, delivery dates, shipping estimates and best means of shipping.

**Customer-site installations are thorough.**
Tektronix provides on-site installation for most computer graphics products and most Tek-configured systems for computer graphics, semiconductor test, microprocessor development, and acquisition/processing. The Tektronix service specialist will make sure your equipment is set up properly with all functions operating to specifications, and will walk you through the basics of its performance.

**Training and assistance gets users up to speed, fast.**
Your Tektronix product is most useful to you when you're thoroughly familiar with it. Ask your Sales Engineer for a demonstration.

Tektronix also offers formal classes and self-study aides. Ask your Sales Engineer for details about Customer Training.

**Test and Measurement Seminars**
Tektronix instruments and programmable instrument systems represent the upper limits of productivity potential. Tektronix has designed seminars to help enhance your understanding of the capabilities of your equipment.

Customer Training Seminars naturally complement the Tektronix commitment to help you achieve optimum utilization of your equipment—A commitment that begins with engineering excellence and continues through training—helping you to develop new and more productive applications, fast!

These fast-paced courses, conducted at key locations throughout the U.S., combine classroom lectures with supervised, hands-on laboratory sessions. Participants receive manuals and workbooks containing detailed course notes and lab exercises.

If you are interested in registering for one of these seminars or would like more information on a particular seminar, call instrument group customer training at (503) 642-8013 or write:

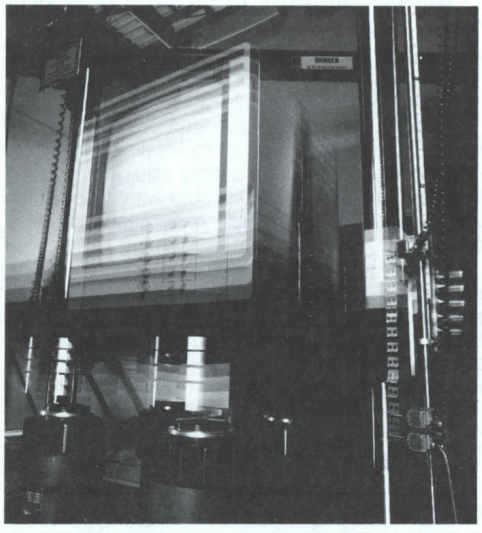
Tektronix, Inc.
Customer Training
P.O. Box 500 M/S 54-074
Beaverton, Oregon 97077

For your convenience, Tektronix also offers private seminars conducted at your company. Call us for more information.

The following products have customer training available:

| | |
|---|---|
| 7854 | 2230 |
| 2465 | 2220 |
| 2445 | MS3101 |
| 2430 | MS3201 |

## Check the Specifications. You'll Find Long Product Life Designed-In.



### Reliability Standards Second to None

Tek products are engineered for high reliability from the initial stages of design. Components and assembled products of every prototype and preproduction model are subjected to "accelerated-life" reliability tests in our Labs. If any fall short of Tek Standards, changes are made.

Manufactured products are thoroughly tested before they're fitted in custom-designed, lab-tested shipping cartons.

### Product Specifications to Meet Your Environment

In Tek's Environmental Labs, field conditions are taken to extremes. Shock, vibration, high humidity, electromagnetic radiation, electrostatic discharge, power line surge, high/low temperature and altitude tests are conducted.

The environmental characteristics listed among the product specifications in this catalog may include some or all of the above types. The specification limits for humidity, vibration, shock and transportation are intended to be beyond what is expected in use. Operation at these extremes may cause minor physical deterioration but should not cause electrical performance to deteriorate outside specifications. Continual use at the specified limits of temperature and altitude should not cause significant short-term deterioration. Higher temperature will reduce long-term reliability. The EMC test is completely nondestructive.

## GENERAL TERMS OF SALE

### Credit and Payment Terms

Tektronix, Inc. offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning.

Credit accommodations must be arranged with Tektronix's Credit Department. Orders and request for credit accommodations should be placed with your local Tektronix Sales Office, listed on the inside back cover.

If, in the judgement of Tektronix, the financial condition or payment record of the Buyer at any time does not justify shipment of order on the payment terms requested, Tektronix may refuse to ship unless it receives payment in advance, or at its option, payment upon delivery of equipment. Businesses established for six months or less may not meet minimum requirements for extended and/or installment terms of sale.

The following terms may be arranged with a Tektronix Sales Office:

### Net 30 Days Standard Terms

Standard terms of sale are Net 30 days following the date of invoice. There are no discounts for early payment.

### 60, 90 and 120 Days Extended Terms of Sale

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended. Request for extended terms must be made at the time of order placement.

### Installment Purchases—Security and Lease Agreements

This program provides monthly installment payment terms while Tektronix Products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

Security and Lease terms are not invoiced. Reminders of each installment are sent to the customer 10 days prior to the due date. The due date of each monthly payment on an installment term will be approximately 30 days from the date of shipment and every 30 days thereafter until completion of the contracted term. Failure to receive any reminder notice from Tektronix shall not affect customer's obligation to pay charges when due.

Except for standard warranty, maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance is not provided under either a Security Agreement or a Lease Agreement. Additional maintenance coverage may be purchased where offered as an option to the instrument or may be purchased as a separate transaction. Maintenance ordered as an option may be financed along with the product.

The customer is required to pay applicable property taxes, licenses, etc. and furnish adequate insurance to Tektronix for loss and damages for both Leases and Security Agreements.

### Security Agreement

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from $1000 for six months to $2000 for thirty-six months. Longer terms of 48 months to 60 months are available by quotation for financed balances of more than $25,000. There are no maximum finance balances. Upon completion of the term of the Security Agreement and prescribed payments, the customer owns the equipment.

### Lease Agreement (Minimum is $1,000)

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price. Not available for Information Display Products.

### Information Display Products

Information Display Computer Graphics Products are available under 3 expanded Leasing programs. Terms vary from 90 days to 4 years.

*Comprehensive Lease* — This full service lease provides 7 features ensuring customer flexibility. Key features include maintenance, product upgrade, and purchase credits. *Basic Lease* — Customers can use this program to acquire Information Display Products at our lowest monthly rates. *Ownership Lease* — This even payment plan ensures title transfer at the lease end. No down payment or ending balloon payment is required.

In addition to these standard programs, specialized leasing programs answer customer needs in the areas of new product evaluation, short term rental, supplying interim products for delayed items, credit acceptance, and others. Custom Leases can also be structured, providing a tailored solution for individual customer requirements.

### Minimum Order

The minimum acceptable order is $25.00.

### Shipment

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical method and air shipments will be insured at full valuation unless your order instructs otherwise.

Copyright © 1985, Tektronix, Inc. All rights reserved. Lithographed in Canada. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX, TEK, PLOT 10, TEKTEST, SCOPE-MOBILE, and [TM] are registered trademarks. For further information, contact: Tektronix, Inc., Corporate Offices, P.O. Box 500, Beaverton, OR 97077. Phone: (503) 627-7111; TLX: 151754; TWX: (910) 467-8708; Cable: TEKWSGT. Subsidiaries and distributors worldwide.

## HARDWARE WARRANTY SUMMARY

Tektronix warrants to its Customers that the products that it manufactures and sells will be free from defects in materials and workmanship for the periods set forth in the table below. If any such product proves defective during the applicable warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site for certain categories of products, as indicated in the table below, if Customer's site is within the normal on-site service area. Tektronix will provide on-site service outside the normal on-site service area only upon prior agreement and subject to payment of all travel expenses by Customer. In all other cases, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the service center is located. Customer shall be responsible for paying all shipping charges, duties and taxes, if the product is returned to any other location. The locations at which the services will be provided for different categories of products or product groups are set forth below.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modiified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

**THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE A DEFECTIVE PRODUCT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.**

| PRODUCT CATEGORIES | WARRANTY PERIOD | SERVICE LOCATION |
|---|---|---|
| Oscilloscopes (except 2200, 2300, 2400 Series) and Plug-ins; TM 500/TM 5000 Series; Communications Network Analyzers (except 834 Series, 835 & 836); Logic Analyzers; Spectrum Analyzers (except 494 and 494P); Television Products (except 1980 and 650 and 690 Series); Waveform Digitizers; Curve Tracers; Photometers/Radiometers; Cameras; Carts; Probes; CRTs; and Isolators | 1 year from date of shipment | Service Center designated by Tektronix |
| Oscilloscopes: 2200, 2300, 2400 Series; Spectrum Analyzers: 494 and 494P; Monitors: 650 and 690 Series; Communications Network Analyzers: 834 Series, 835, 836 and 067-0986-00 | 3 years from date of shipment | Service Center designated by Tektronix |
| Monitors: 606B, 608, 620, 634 | 3 months, except 1 year from date of shipment for CRT | Service Center designated by Tektronix |
| Computer Graphics Products (except those listed below); Intelligent Graphics Workstations; Monitors: GMA 201, 1980 ANSWER; 4041 Controller; Software Development Products (except V-Systems, 856140 Series); Artificial Intelligence Machines | 3 months, except 1 year from date of shipment for CRT | Customer's site if within normal on-site service area |
| Computer Graphics Products: 4104A, 4105A, 4106A, 4107A, 4109A, CX4106A, CX4107A, CX4109A | 1 year from date of shipment | Customer's site if within normal on-site service area |
| Acquisition/Processing Systems; Semiconductor Test Systems; Software Development Products: V-Systems, 856140 Series | 3 months, except 1 year for CRT, beginning on the date of installation by Tektronix, or one month from date of shipment, whichever is earlier | Customer's site if within normal on-site service area |
| Parts, Assemblies, Supplies and Test Fixtures: All 9-digit part numbered items except Probes, CRTs, and 067-0986-00 | 3 months from date of shipment | Service Center designated by Tektronix |
| Service | 3 months from date of shipment or date of completion if performed on-site | Location where original service was performed |

## SOFTWARE WARRANTY SUMMARY

Tektronix warrants that any software product for which Tektronix publishes a corresponding "Software Product Description" will conform to the specifications set forth in the Software Product Description, when used properly in the specified operating environment, for a period of three (3) months. The warranty period begins on the date of shipment, except that if the program is installed by Tektronix, the warranty period begins on the date of installation or one month after the date of shipment, whichever is earlier. If any such software product does not conform as warranted, Tektronix will provide the remedial services specified in the applicable Software Product Descriptions. Tektronix does not warrant that the functions contained in the software product will meet Customer's requirements or that operation of the programs will be uninterrupted or error-free or that all errors will be corrected. Software products for which Tektronix does not publish a Software Product Description, or for which Tektronix does not set forth specifications in the Software Product Description, are provided "as is" without warranty of any kind, either express or implied; except that, Tektronix warrants that the media on which such software products are provided will be free from defects in materials and workmanship for a period of three (3) months from the date of shipment. If any such medium proves defective during this warranty period, Tektronix will provide a replacement in exchange for the defective medium.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for such service in accordance with the instructions received from Tektronix. If Tektronix is unable, within a reasonable time after receipt of such notice, to provide the remedial services specified in the applicable Software Product Description, when such services are indicated, or provide a replacement that is free from defects in materials and workmanship, Customer may terminate the license for the software product and return the software product and any associated materials to Tektronix for credit or refund.

This warranty shall not apply to any software product that has been modified or altered by Customer. Tektronix shall not be obligated to furnish service under this warranty with respect to any software product a) that is used in an operating environment other than that specified or in a manner inconsistent with the User's Manual and documentation or b) when the software product has been integrated with other software if the result of such integration increases the time or difficulty of analyzing or servicing the software product or the problems ascribed to the software product.

**THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE LISTED PRODUCTS IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO PROVIDE REMEDIAL SERVICE WHEN SPECIFIED, REPLACE DEFECTIVE MEDIA, OR REFUND CUSTOMER'S PAYMENT IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.**

**For further details regarding OEM or specific hardware or software warranties, please consult your local sales office.**

# PROTECTION FOR TEK PRODUCTS

**Solid Support**
To ensure maximum uptime and top performance, every Tektronix product is backed by our worldwide service organization.

Fast, on-site response and quick turnaround are provided by almost 60 service points in the USA alone, plus service offices in over 60 other countries.

**Service Professionals**
Over 1,400 Tek-trained personnel, including Customer Service Representatives, Specialists, and other members of your local Tek Service team, have one objective—maximize customer uptime.

We back our specialists with regional and factory support, specialized diagnostic tools, updated documentation, and the world's best service instruments.

No one can match our large, local inventories of latest version Tek modules, assemblies and other parts.

**A Lifetime of Service**
**A Comprehensive Warranty,** as specified on page 454, accompanies every new, serialized product.

**Warranty-Plus Options** provide low-cost extended coverage for selected products. See page 457.

**Annual Support Agreements**, described here and on page 456, ensure maximum uptime.

**Other Service Offerings** include "Per-incident", FIRM PRICE, "Per-Call", self-maintenance support, Installation, and Time-and-Material services.

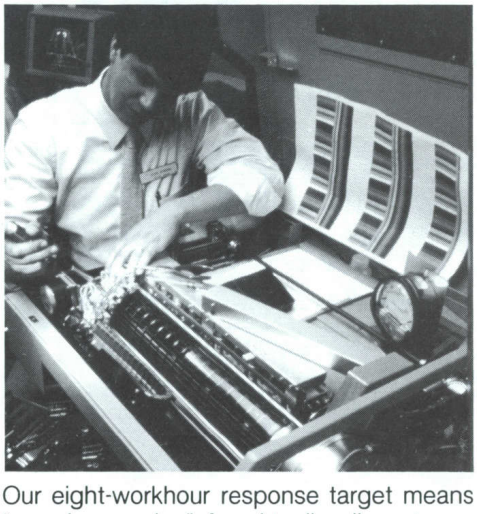
**Our Long-Term Support Program** provides full service support for products long out of production. Following a product's support phase, we will use our best efforts to continue support if experienced technicians and the necessary parts are available.

**Ready to Help You**
Custom services available at selected offices are not included in this catalog. Likewise, not all USA programs described here are offered in every country. For prices and specifics in your area, call the Tektronix Sales, Service or Distributor Office nearest you.

## CUSTOMER-SITE SUPPORT

*For design and graphics products, we offer fast, on-site service to eliminate downtime. It's available through Customer-Site Support Agreements or on a "Per-Call" basis.*

**Annual Customer-Site Support Agreements.** Our fastest response is reserved for agreement holders. All travel, parts and labor are covered. To maximize uptime, preventive maintenance is included to inspect, clean, and adjust your equipment to peak performance. Many available engineering upgrades, also performed at no extra charge, will update performance, safety, and reliability with current production versions of your product.



Our eight-workhour response target means "one-day service" for virtually all customer sites in the contiguous USA during normal business days. For even faster response, multi-shift or weekend coverage, ask about our Customer-Site Agreement Options. Contact your local Tek office or call 1-800-835-6100 for prices and details.

**Per-Call Service.** Dependable on-site service is also available for design and graphics products at time-and-material rates plus travel expense. Repairs are warrantied for 90 days.

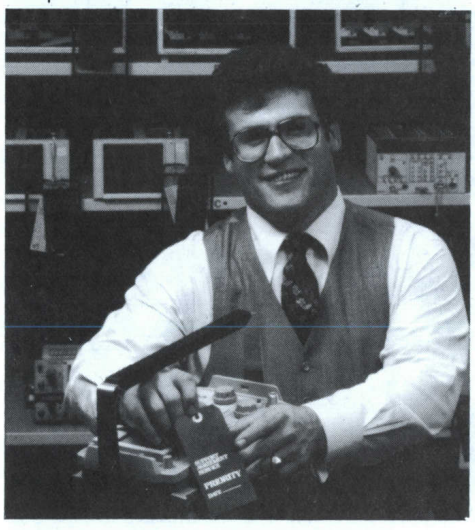
**Installation/Relocation Services.** Tek offers expert moving and system set-up services at fixed-fee or "Per-Call" rates.

**Software Update Agreements** provide current releases of Tektronix licensed software and updates to software documentation. Call 1-800-835-6100 to order agreements on IGW, PLOT 10, AIM, and LoPro software. Call your Tek sales engineer for agreements on SDP software.

**Technical Assistance Services** may be obtained by calling your local Tektronix applications engineer for help in implementing Tek software, training users, or solving applications problems. The scope of assistance can be defined before costs are incurred.

# SERVICE CENTER SUPPORT

For instrumentation products, there are several support alternatives summarized in the charts below. Discounts are available. There are some eligibility requirements and exclusions. Call your local Tek office for complete information.

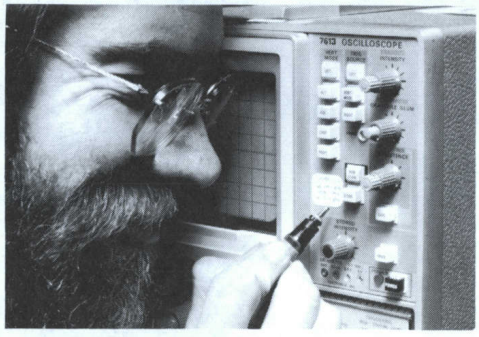


### Annual Service Center Support Agreements

Annual agreements are available in five levels of support. All provide top priority turnaround. Coverage usually costs less than a single repair and calibration. Discounts are available and Tek pays one-way shipping.

| | REMEDIAL | BASIC | TOTAL | STANDARD | CAL ONLY |
|---|---|---|---|---|---|
| Minor Cleaning Cosmetics | | | ● | ● | ● |
| Repair Labor | | ● | ● | ● | ● |
| Non-CRT Repair Parts | | ● | ● | ● | |
| CRT Coverage | | | ● | | |
| Mod-Updates | ●** | ● | ● | ● | |
| Scheduled Cal | | | ● | ● | ● |
| Cal Labor | | ● | ● | ● | ● |
| Cal Certification* | | | ●* | ●* | ●* |
| Before & After Test Data* | | | ●* | ●* | ●* |
| Additional Cals* | | | ●* | ●* | ●* |

* Optional ** Limited



### "Per Incident" Service

Remedial service performed at a Tektronix Service Center is available for most instrumentation products.

**Time and Material Service** restores performance to most damaged or discontinued products. Obsolete products may require a written quote which you approved to initiate repair.

**The *FIRM PRICE* Program** gives you, in advance, the exact cost to repair and/or calibrate your instruments. Mini-fees may apply when the repair requires less than an hour's labor. Contact your local Tek office for complete *FIRM PRICE* information.

| | CAL & REPAIR | REPAIR ONLY | CAL ONLY |
|---|---|---|---|
| Minor Cleaning Cosmetics | ● | ● | ● |
| Repair Labor | ● | ● | |
| Non-CRT Parts | ● | ● | |
| Cal Labor | ● | | ● |
| Cal Certification[1] | ● | | ● |
| Before & After Test Data[2] | ● | | ● |
| Repair Mini-Fee[3] | | ● | ● |

[1] *Optional with Calibration.*
[2] *Optional with Certified Calibration.*
[3] *Conditional*

# SELF-MAINTENANCE SUPPORT

For customers who choose to perform their own maintenance, Tek Service offers the following support service.

**Parts and Supplies** are available. To order, call your nearest Tektronix office and give the part name, product model and serial number to the Parts Order Desk.

**Module Repair and Return Services** for specified modules of graphics and design products are obtained through our Module Repair Center, Factory Service, Beaverton, Oregon. For complete details, request a copy of our Module Service Price List, 81-A-6032.

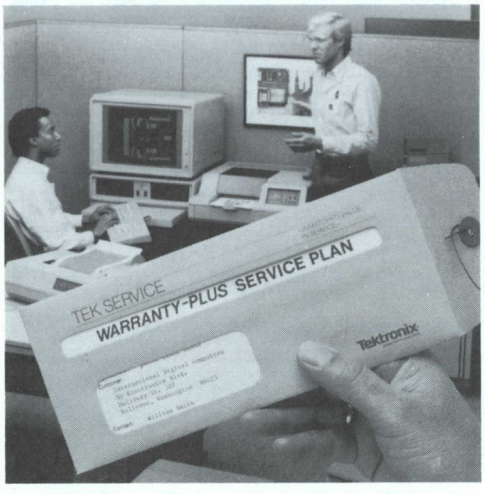
**Provisioning (Service Sparing)** can be arranged by your Tek sales engineer. Tek will recommend the appropriate spares for your products and provide them to your specifications.

**Test Fixtures and Calibration Aids** can be purchased through your local Tek office. Consult this catalog for product-specific test fixtures and aids which are identified under most product listings or request a copy of the current Logistics Data Book, 99-W-5859.

**Our Service Training Program** includes classes and self-study aids in a variety of electronic, service-related subjects. Formal classes are offered at various Tek locations and, in some cases, are conducted at customer sites. For a listing of audio, video, and printed study aids in our training library, obtain a copy of the Customer Service Training Catalog, 81-A-5779, from your local Tek office or by completing the reply card in this catalog.

**Service Publications** available to customers include Service Manuals (circuit schematics, parts lists, operating maintenance, trouble-shooting information), TEKNOTES Newsletter, and Microfiche Service Manuals with updates. Order printed manuals as you would any part. Request a subscription to TEKNOTES through your Tektronix representative. Microfiche manuals (all ANSI standard 105 mm x 148 mm) and yearly subscriptions to new or revised service information on microfiche may be ordered by product, entire group or product line series, or as a full set of all Tektronix products. Contact your local Tek office for a Microfiche Products Files Catalog, 81-W-5678.

# WARRANTY-PLUS COVERAGE COSTS LESS




For select Tektronix products, you may order *Warranty-Plus* Service Plans at the time of product purchase. *Warranty-Plus* offers comprehensive coverage at the lowest cost.

With *Warranty-Plus*, the full value of your equipment investment is ensured from the start. Coverage is continuous, beginning the moment your New Product Warranty expires.

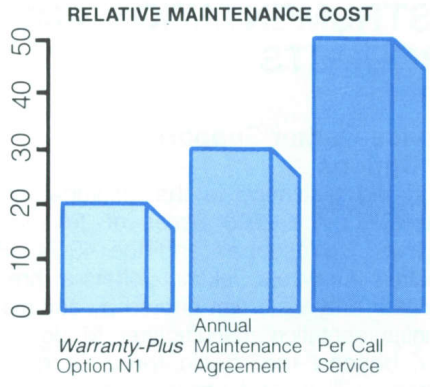
By paying one, upfront charge at the time of product purchase, you can forget about maintenance cost for at least one full year or, in some cases, up to five years. Nothing makes budget planning easier. And, you are protected against increases in service rates.

*Warranty-Plus* means maximum uptime. You receive priority service. Approval or paper-work delays are eliminated. Preventive maintenance and scheduled calibrations are included in plans, as appropriate, at no additional cost.

And, unlike annual support agreement pricing, there is only one *Warranty-Plus Service* charge per product, with no added charges for the extra equipment options you may select. And because *Warranty-Plus* Service Plans are purchased as a product option, quantity discounts apply to save you even more.

Complete coverage descriptions and prices are available from your Tektronix sales engineer.

# WARRANTY-PLUS FOR DESIGN AND GRAPHICS PRODUCTS




## Installation and Set-Up OPTION NØ

Under *Warranty-Plus* Installation Plan NØ (N "zero"), Tektronix will install, set-up, and verify performance at the customer's site. All labor and travel within 75 miles of a Tek Service Office is included. Installation at end-user sites is also available for OEM purchases under *Warranty-Plus* Option N4. Ask your sales engineer for literature and prices.

## First Year Coverage OPTION N1

For about the cost of one customer-site service call, you can extend 90-day service coverage on most design and graphics products and systems to a full year. *Warranty-Plus* Customer-Site Support covers travel, modules, all parts (including CRT), and labor to keep your equipment functioning to published specifications. It includes the appropriate number of preventive maintenance calls to inspect, test, clean, and adjust your equipment to optimum performance. Many available engineering updates are performed at no extra charge to enhance performance, safety, and reliability. With quick response to your call, a Tek specialist will perform remedial repairs as well as maintain mechanically-based copiers, plotters and disk drives, fully test Tek-configured systems, and adjust CRTs.

Option N1 is only available with standard end-user sales of most Information Display products and Tek-configured systems, and only at the time of product purchase. Specify "Option N1" when ordering. First year service coverage is also available for OEM purchases under *Warranty-Plus* Option N3.

| Month of Ownership | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Warranty Only | Warranty Coverage | | | | | | | | | | | |
| *Warranty-Plus* Option N1 | Warranty Coverage | | | *Warranty-Plus* Coverage | | | | | | | | |

## Three Year Coverage OPTION N2

Tek 4104A through 4109A (and -CX versions) Color Terminals carry a one year New Product Warranty. With *Warranty-Plus* Customer-Site Option N2, service coverage is extended for two additional years at very little cost. In fact, coverage for the 2nd and 3rd years costs less than one average on-site service call. Less than a one-year annual support agreement you may purchase later. Option N2 is only available on the 4104A through 4109A (and -CX versions) terminals and only at the time of product purchase. Specify "Option N2" when ordering.

| Year of Ownership | 1 | 2 | 3 |
|---|---|---|---|
| Warranty Only | Warranty Coverage | | |
| *Warranty-Plus* Option N2 | Warranty Coverage | *Warranty-Plus* Coverage | |

## First Year Software Update Coverage OPTION N9

Option N9 maintains Tek-licensed software at its highest revision level during the first year of ownership, at no charge. It provides (1) appropriate media and documentation, (2) access to Tek's software development process, and (3) price protection against damage to original media. Specify "Option N9" prior to product shipment.

| Month of Ownership | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Warranty Only | Warranty Coverage | | | | | | | | | | | |
| *Warranty-Plus* Option N9 | *Warranty-Plus* Coverage | | | | | | | | | | | |

# *WARRANTY-PLUS* FOR SELECTED INSTRUMENTATION AND COMMUNICATIONS PRODUCTS

### Service Center Support 'M' Options

As strong testimony to the incomparable reliability of the 2000 Series of Tektronix portable oscilloscopes and the 494/494P Spectrum Analyzers, Tektronix offers a **three year warranty**—the first offered by any major instrumentation manufacturer to do so. Now, beyond the "basic three years"—Tektronix will extend service coverage up to five years, offering you a choice of three practical *Warranty-Plus* Service Center Support Options to meet your needs.

**One Up-Front Fee Pays for Itself and More.** *Warranty-Plus* costs less than annual contracts for the same service you may purchase later. And far below standard repair or single calibration costs.

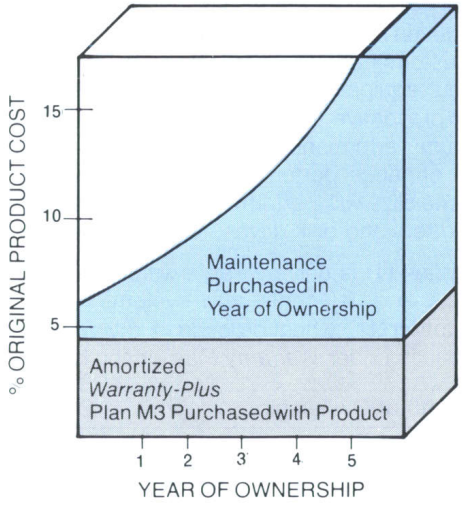
You also save money because your contract will limit your costs, no matter how much service rates may increase.

You'll get more uptime, too, because with a *Warranty-Plus* Service Plan, you won't experience delays in needed service because of unplanned expense, approvals, or paperwork.

Tektronix helps you manage your maintenance costs with just one known, up-front charge.

Optional *Warranty-Plus* Plans are only available on 2000 Family portable oscilloscopes and the 494/494P Spectrum Analyzers, and only at the time of product purchase. Specify "Option M1, M2, M3, M4, or M5" when ordering.

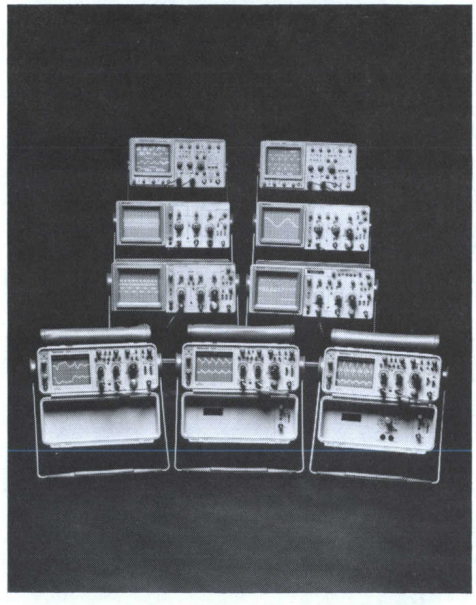
**ANNUAL MAINTENANCE COST**




**THREE OR FIVE YEAR COVERAGE OPTIONS M1-M5**

| Year of Ownership | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Warranty | | Warranty Coverage | Warranty Coverage | Warranty Coverage | — | — |
| Optional *Warranty-Plus* Service | Plan M1 | — | 1 Calibration | 1 Calibration | — | — |
| | Plan M2 | — | — | — | Remedial Coverage | Remedial Coverage |
| | Plan M3 | — | 1 Calibration | 1 Calibration | 1 Calibration + Remedial Coverage | 1 Calibration + Remedial Coverage |
| | Plan M4 | 1 Calibration with Certification | 2 Calibrations with Certification | 2 Calibrations with Certification | — | — |
| | Plan M5 | 1 Calibration with Certification | 2 Calibrations with Certification | 2 Calibrations with Certification | 2 Calibrations with Certification + Remedial Coverage | 2 Calibrations with Certification + Remedial Coverage |

# *WARRANTY-PLUS* CONDITIONS



**International *Warranty-Plus* Options, Customer Responsibilities and Coverage Exclusions.**

*Warranty-Plus* is available in most countries, but service is only provided in the country where the product and plan are purchased. *Warranty-Plus* Service purchased in the United States is only valid within the United States.

In the United States, service is performed during normal business hours. For most Information Display Products or Tek-configured Systems, service is provided at the customer's site with no travel charges, within eight work hours of notification, if the site is within 75 miles of a Tektronix Service Center. If not, response may be longer.

Our 2000 Family portable oscilloscopes and the 494/494P Spectrum Analyzers receive priority service at a Tek Service Center. Under Options M1, M2, M3, M4, and M5, it is the customer's responsibility to deliver the product for servicing at the service center designated by Tektronix, with shipping charges prepaid. Return shipping is paid by Tektronix.

Outside the United States, response and turnaround times may be different. Consult the Tektronix subsidiary or approved distributor in your country.

As you may expect, service under a *Warranty-Plus* Agreement does not apply if the failure is caused by misuse or inadequate care or maintenance, such as:

a) damage from repair attempts by non-Tektronix personnel;

b) improper use or connection to incompatible equipment; or

c) modification or integration that increases time or difficulty in servicing your product.

## OEM COMPONENTS

**Special Information for OEM**
At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation—we offer these and other products on a special basis to the original equipment manufacturer.

But terms and conditions tell only part of the Tektronix OEM story. Our products have the quality, reliability, and top performance per dollar that the OEM needs to stay competitive.

**Choose the Performance Level to Match Your System**
In many product areas our wide range of OEM components allows you to select just the optimal performance you need for the system you are building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you select exactly the performance level you need—no more, no less.

**Special OEM Terms and Pricing Help Keep You Competitive**
Ask your local Tektronix representative about the special OEM terms and pricing available to you.

**Service and Support—When and Where You Need It**
Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

**You and Tektronix: A Quality Partnership**
Explore the advantages of working with Tektronix: excellence in products, support, and service.

Your local Tektronix representative can help you obtain full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.

## POWER SOURCE CONSIDERATIONS

Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below and wired for the voltage as indicated, if specified on the purchase order.

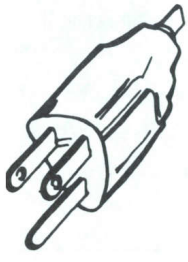
| | | |
|---|---|---|
| North American | 120 V | Standard |
| Universal Euro | 220 V | Option A1 |
| United Kingdom | 240 V | Option A2 |
| Australian | 240 V | Option A3 |
| North American | 240 V | Option A4 |
| Switzerland | 220 V | Option A5 |

The power cord/plug options may become available on instruments not specified in this catalog. Refer to the individual product ordering information for those products offering these options as of publication date.

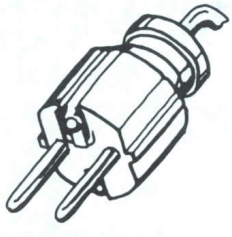
Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

Power-cord coding follows one of the two following schemes:

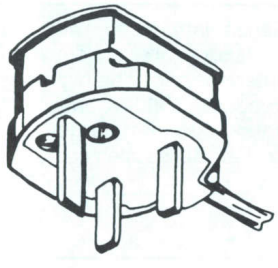
| | Scheme 1 | Scheme 2 |
|---|---|---|
| Line | Black | Brown |
| Neutral | White | Light blue |
| Ground (safety earth) | Green-yellow | Green-yellow |



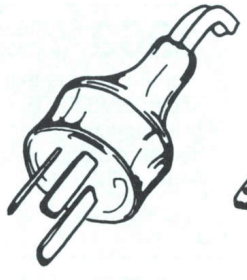
**Standard**
**North American**
**120 V/15 A Plug**



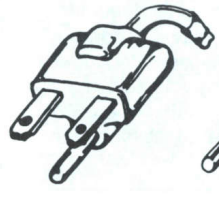
**Option A1**
**Universal Euro**
**220 V/16 A Plug**



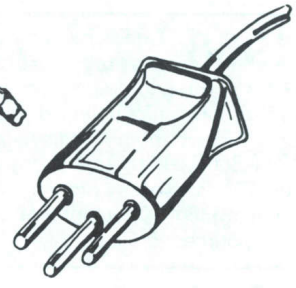
**Option A2**
**UK**
**240 V/13 A Plug**



**Option A3**
**Australian**
**240 V/10 A Plug**



**Option A4**
**North American**
**240 V/15 A Plug**



**Option A5**
**Switzerland**
**220 V/10 A Plug**

# TEK HIGHLIGHTS

**1946** Tektronix, Inc., an Oregon corporation certified 2/2/46: 200 shares @ $100 par. Shareholders: Murdock, Vollum, McDowell, Tippery & Bave (Castles)

**1947** **511 oscilloscope: first "triggered" scope.** First scope sold to the University of Oregon Medical School, 511 (May)

**1951** Tektronix decided to produce its own cathode ray tubes (CRT).

**1952** 514 oscilloscope; general purpose scope. 517 oscilloscope: special scope for atomic energy program; for observation and photography of fast-moving waveforms made possible by widest bandwidth available. **315 oscilloscope: first scope to use a "linear ramp" to develop sweep.**

**1956** Introduction of the Kobbe/Polits passive probe. Development of distributed vertical amplifier (Kobbe/Polits)

**1957** Patent infringement occurred which resulted in the 1961 U.S. Court of Claims case. 316 oscilloscope: wideband, DC coupled portable. RM16 oscilloscope: 3 inch rackmounted scope. **575 curve tracer: first "transistor curve tracer".**

**1958** 502 oscilloscope: dual beam and high sensitivity.

**1962** Development of direct-view, bistable storage-tube (Anderson Tube) or DVST. 564 oscilloscope: first scope to use DVST. Introduction of automatic sweep device. 567 oscilloscope: first Tektronix digital readout oscilloscope.

**1963** Policy changes by U.S. Govt. result in decentralization of sales function of Tektronix, Inc. producing reorganization of Tektronix:

- Tektronix Ltd. formed to sell Tektronix products to distributors in Europe, Africa & the Middle East (March)
- Tektronix U.K. Ltd. formed for sales and service (June).

**1964** N. Winningstad advanced idea that Tektronix develop information display devices now possible because of DVST.
Howard Vollum personally launched the 7000 oscilloscope project.

**1968** Decision to produce information display products (IDP). 601/611 Storage display units; alphanumeric and graphic information display for computers. 323 portable oscilloscope introduced from Sony/Tektronix. 410 Physiological monitor. S-3100 Series: programmable measurement system. **Development of Wilson current source.**

**1969** **7000 Series introduced with the 7704 oscilloscope: accommodated 4 plug-ins; interface capacity; high speed DVST; CRT readout. T4000 Series graphic computer terminals: first large-screen storage device.** 4500 Series scan converter units.

**1970** **Development of Gilbert gain cell.**

**1974** 21/31 Series programmable calculators. **4023 Series: first refresh terminals. 200 Series oscilloscopes: ultra-miniaturized scope.** Liquid crystal color shutter (LCCS) picked as key technology.

**1975** 4050 Series: small desk-top systems. WP1100 Series oscilloscope: digital processing scope. S3400 Series test systems.

**1976** T900 Series oscilloscopes: small portables. WP1205 Series oscilloscope: digital processing oscilloscope (DPO). 414 Portable patient monitor.

**1980** 300 Series Logic Analyzers from Sony/Tektronix. Software Center established to insure quality & productivity of Tektronix-produced software.

**1981** Transition from the storage tube to rastor scan (video scan). 2200 Series portable oscilloscopes: the entry of Tektronix into low-end scope manufacture. 7D02 logic anlayzer for the 7000 Series. 8550 microcomputer development lab. DAS9100 digital analysis system.

**1982** Tektronix produced ink-dot copier.

Bolder type indicates Tektronix firsts in the electronic industry.

**1948** 511A oscilloscope: first application of high-frequency power supply. 512 oscilloscope: low-frequency direct coupled with unblanking circuitry. 104 Series voltage calibrator. 105 Series square wave generator: first wide-range wave generator.

**1949** Tektronix began to produce its own transformers and inductors.

**1950**

**1953** First year Tektronix patented its own circuit designs. 530 Series oscilloscope: first plug-in scope; contained innovative sweep circuitry, trigger circuit and hold-off circuit (Kobbe sweep circuit). Introduction of the 50 Series plug-ins. First patent filed by Tektronix: No. 2,752,527 sweep magnification (Ropiequet) Development of ceramic terminal strip technology.

**1954** 315D oscilloscope: first portable scope, integrating the new Tektronix flat-faced CRT. 524D oscilloscope: specifically designed for television industry; triggered from television signal.

**1955** 540 Series oscilloscope: fast-rising plug-in scope with vertical amplifier. 310 small portable oscilloscope. 515 oscilloscope: DC coupled general purpose scope. 360 oscilloscope for hospital use.

**1959** Robert Anderson, eventual inventor of the storage tube, joins Tektronix. 580 Series oscilloscope: faster rise-time plug-in. 526 oscilloscope: first "vectorscope" provided precise TV color signal analysis. N-unit: first sampling plug-in.

**1960** 321 portable oscilloscope: first solid-state scope; battery powered. Introduction of first oscilloscope camera. 519 oscilloscope: 1 GHz bandwidth.

**1961** Tektronix filed suit against the U.S. Government, *et al*, over patent infringement: U.S. Court of Claims case (Tektronix won judgment in 1971). Tektronix adopted patent policy (amended March 1962). Development of ceramic CRT envelope. 661 oscilloscope: first sampling oscilloscope.

**1965** 3A5 Plug-in: first triggered dual trace plug-in unit. Decision to produce integrated circuits. 491: first general purpose "portable spectrum analyzer". Introduction of tilt bail handle for portable scopes.

**1966** 453 oscilloscope: small portable in response to needs of IBM for small portable. Type 263 Programmer: enabled 1 to 6 programmed functions on an oscilloscope.

**1967** Decision to produce computer terminals. 454 oscilloscope: first "video bandwidth portable" scope.

**1971** U.S. Court of Claims rules in favor of Tektronix in the 1961 suit vs. U.S. Government *et al*. Annual Report stated that 110 new products were "announced or introduced" this year, among them: 1701/1702 machine control units, and the 4601 hard copy unit. Decision to add intelligence to Tektronix hardware led to acquisition of CINTRA.

**1972** 326 oscilloscope: dual trace miniaturized scope. 4010 computer display terminal. S3002/3206 automated test systems. Tek-Labs established (August).

**1973** TM 500 Test and Measurement Systems.

**1977** 4081 Interactive graphics system. 670A Color TV monitor. Applied Research Group established (October).

**1978** 634 Raster scan display. 4020 Series graphics systems for alphanumerics. Decision to produce Ga-As circuits, faster, lower-powered than silicon.

**1979** 4027 color graphics display terminal. 4600 Series plotting devices. S3200 Series automated semiconductor test systems. 492 Series spectrum analyzer. 7104 oscilloscope: first gigahertz general purpose scope, fastest writing speed in the world.

**1983** 2400 Series oscilloscopes: state-of-the-art small portable scope. First Ga-As circuits. 4100 Series "Unicorn" graphics terminals. 4115B Series color graphics terminals: top dollar new product in Tek history.

**1984** 494 Series 325 GHz spectrum analyzers. 4404: First Artificial Intelligence (AI) product. Received Emmy award from National Academy of Television Arts and Sciences for engineering excellence in television test, measurement, and monitoring technology.

**1985** New CAE System Division formed: announces ability to tie computer-aided design to test and measurement. 3 new digital storage oscilloscopes. Computer Based Instruments features new architecture which blends computer and instrument functions.

Bolder type indicates Tektronix firsts in the electronic industry.

**For customers outside listed countries, contact your nearest area office:**

## Asia, Central & South America

### Tektronix, Inc., Americas Pacific U.S. Export Sales
P.O. Box 500, MS 51-297
**Beaverton, Oregon** 97077
U.S.A.
Phone: (503) 643-8868 or
(800) 547-1165
Telex: 4742103 TEKWSGT

## Africa, Middle East and Western Europe

### Tektronix Limited
P.O. Box 36
**Guernsey**, Channel Islands
Phone: 44 (481) 711211, 35781
Telex: (851) 4191193 TEKGNY G

## Eastern Europe

### Tektronix Ges.m.b.H
Doerenkampgasse 7
A-1100 Vienna
Austria
Phone: 43 (222) 68-66-02
Telex: (847) 111481 TEK A

---

### ALGERIA
**Product Information**
### Tektronix, Bureau de Liaison-Algerie
Bureau N5, Niveau C
Hotel El-Aurassi
BD Frantz-Fanon
Alger
Phone: 213 () 648252, Ext-665
Telex: 51243 TEK DZ

**Service**
### Entreprise Nationale Des Industries Electroniques
Unite de Maintenance et Calibration
des Equipements Electroniques
MCE 1, BP 121
Route de Mascara - Zone Industrielle
Side Bel-Abbes
Phone: 213 () 242269
Telex: 16021 MCE1 DZ

**Sales Office**
### Tektronix Limited
P.O. Box 36
Guernsey, Channel Islands
Phone: 44 (481) 35781, 711211
Telex: (851) 4191193 TEKGNY G

### ARGENTINA
### Coasin Computacion S.A.
(IDG Products Only)
Moreno 490
1091 Buenos Aires
Phone: 54 (1) 33-0195/0402/0405
Telex: (390) 17016 COCOM AR

### Coasin S.A.
(T&M Products Only)
**Buenos Aires Office**
Virrey del Pino 4071
1430 Buenos Aires
Phone: 54 (1) 552-3185/5248/3485;
551-9361
Telex: (390) 22284 COASN AR

**Cordoba Office**
25 de Mayo No. 1930
Cordoba
Phone: 54 (51) 3037

### AUSTRALIA
### Tektronix Australia Pty. Limited
**Sydney Office**
80 Waterloo Road
North Ryde, N.S.W. 2113
Phone: 61 (2) 888-7066
Telex: (790) 24269 TEKTRNX AA

**Adelaide Office**
128 Gilles Street
Adelaide, South Australia 5000
Phone: 61 (8) 223-2811

**Canberra Office**
7 Dundas Court
Townsend Street
Phillip
Canberra, Austr. Capital Terr. 2606
Phone: 61 (62) 82-3655

**Melbourne Office**
CNR, Russell and Council Sts.,
Hawthorn East,
Melbourne,Victoria 3123
Phone: 61 (3) 813-1455
Telex: (790) 35880 TEKMEL AA

**Perth Office**
66 Wellington Street
East Perth, West Australia 6000
Perth
Phone: 61 (9) 325-8433

**Brisbane Office**
737 Logan Road
Greenslopes Brisbane 4120
Queensland
Phone: 61 (7) 394-1155

### AUSTRIA
### Tektronix Ges.m.b.H.
Doerenkampgasse 7
A-1100 Vienna
Phone: 43 (222) 68-66-02
Telex: (847) 111481 TEK A
Fax: 43 (222) 68-66-02-52

**Graz Office**
Foellingerstrasse 9E
A-8044 Graz
Phone: 43 (316) 39-18-10

### BAHRAIN
### Basma W.L.L.
P. O. Box 5701
Manama
Phone: 973 () 25-1364/-6097
Telex: 9003 BSMCO

### BANGLADESH
### A. Q. Chowdhury & Co.
(T&M Products Only)
Mail: P.O. Box 118
Dacca-2
Site: 33 Tophkana Road
Phone: 252329, 312492
Telex: (950) 642418 DCCI BJ

### BELGIUM
### Tektronix nv/sa
Zoning Keiberg
Excelsiorlaan 3
1930 Zaventem
Phone: 32 (2) 720-80-20
Telex: (846) 26713 TEKBEL B

### BOLIVIA
### Coasin Bolivia S.R.L.
(T&M Products Only)
Mail: Casilla 7295
La Paz
Site: Avda 6 de Agosto 2300
Phone: 591 (2) 340962,363365
Telex: (336) 3233 COALAP BV

### BRAZIL
### Tektronix Industria e Comercio Ltda.
Rua Nebraska 459-4° and.
CEP 04560
Sao Paulo, SP
Phone: 55 (011) 543-1911
Telex: (391) 011 21440 TEKX BR

**Rio de Janeiro Office**
Avenida Marechal Camara 160 Gr 605
20020 Rio de Janeiro, RJ
Phone: 55 (021) 240-7370
Telex: (391) 021 30120 TEKX BR

### CANADA
### Tektronix Canada Inc.
**Barrie Office**
Mail: P.O.Box 6500,
Barrie, Ontario L4M 4V3
Site: 50 Alliance Blvd.
Phone: (705) 737-2700
Telex: 06875672 TEKTRONIX BAR

**Calgary Office**
Suite 106
3016, 19th Street NE
Calgary, Alberta T2E 4Y3
Phone: (403) 250-7583
Telex: 03821730 TEKTRONIX CGY

**Edmonton Office**
6025 103 A Street
Edmonton, Alberta T6H 2J7
Phone: (403) 434-9466
Telex: 0372795 TEKTRONIX EDM

**Halifax Office**
Burnside Commercial Centre
60 Thornhill Drive
Dartmouth, Nova Scotia Unit 7
B3B 1S1
Phone: (902) 469-9476
Telex: 01931534 TEKTRONIX DRT

**Montreal Office**
900 Selkirk Street
Pointe Claire, Quebec H9R 3S3
Phone: (514) 697-5340
Telex: 05821570 TEKTRONIX MTL

**Ottawa Office**
1642 Woodward Drive
Ottawa, Ontario K2C 2B8
Phone: (613) 225-2850
Telex: 0534119 TEKTRONIX OTT

**Toronto Office**
89 Galaxy Boulevard
Unit 20-21
Rexdale, Ontario M9W 6A4
Phone: (416) 675-3865
Telex: 06989324 TEKTRONIX TOR

**Vancouver Office**
4519 Canada Way
Burnaby, B.C. V5G 1K1
Phone: (604) 438-4321
Telex: 04354602 TEKTRONIX VCR

**Winnipeg Office**
Unit 6, Border Place
1313 Border Street
Winnipeg, Manitoba R3H 0X4
Phone: (204) 632-4447/-4448
Telex: 0755584 TEKTRONIX WPG

### CHILE
### Equipos Industriales S.A.C.I.
(T&M Products Only)
Mail: Casilla 13550
Santiago
Site: Moneda 812, Of. 912
Phone: 56 (2) 382-942, 725-388
Telex: (359) 241282 FLOBR CT

### CHINA, PEOPLE'S REPUBLIC OF
### Tektronix China Limited
Xiyuan Hotel, Room 102
Erligou, Western Suburb
Beijing
Phone: 890721 Ext. 102
Telex: 22831 XYH CN

### COLOMBIA
### Selectronica, Ltda.
(T&M Products)
Mail: Apartado Aereo 25124
Bogota
Site: Carrera 71 #55-98
Phone: 57 () 263 2874/-1220
Cable: SELECTRONICA

### COSTA RICA
### Electro-Impex, S.A.
(T&M Products)
Mail: Apartado 620-1000
San Jose
Site: Paseo Colon
Calle 26 #305
Phone: 506 () 21-59-54
Telex: (303) 2645 ELEPEX CR

### DENMARK
### Tektronix A/S
Mail: Post Box 144
DK-2750 Ballerup
Site: Lautrophus 1-3
Phone: 45 (2) 97-56-22
Telex: (855) 35239 TEKAS DK
Fax: 45 (2) 68-00-70

### ECUADOR
### Proteco Coasin Cia Ltda.
(T&M and IDG Products)
**Quito Office**
Mail: Apartado 228-A
Quito
Site: Avda. 12 de Octubre 2285
y Orellana
Edificio Jericho,
Planta Baja
Phone: 593 (2) 52-6759/9684
Telex: (393) 22865 PROTEC ED

**Guayaquil Office**
Mail: P.O. Box 9733
Guayaquil,
Site: Calderon #103 y Malecon
Phone: 593 (4) 526093

### EGYPT
### Giza Systems Engineering Co.
(IDG Products Only)
P.O. Box 1913
2 Medan El Mesaha
Dokki, Cairo
Phone: 20 (2) 48-7605/-7588/-4200/
-5174/-7640
Telex: 92096 EKA UN

**Alkan**
(T&M Products)
P.O. Box 1913
2 Medan El Mesaha
Dokki, CAiro
Phone: 20 (2) 48-7605/-7588/-4200/
-5174/-7640
Telex: 93644 ALKAN UN

### FINLAND
### Tektronix Oy
Larin Kyostin tie 4,
SF-00650 Helsinki 65
Phone: 358 (0) 722-400
Telex: (857) 123435 TEKOY SF
Fax: 358 (0) 7520033

### FRANCE
### Tektronix S.A.
**Orsay Office**
Z.I. Courtaboeuf, Av. du Canada
B.P.13
91941 Les Ulis Cedex
Phone: 33 (69) 07-78-27
Telex: (842) 690332 TEKOR A
Fax: 33 (69) 07 09 37

**After Sales Service — France**
Z.I. Courtaboeuf Av. du Quebec
B.P.13
91941 Les Ulis Cedex
Phone: 33 (69) 07 78 27
Telex: (842) 691012 TEKSAV

**After Sales Service — Paris West**
39, Bd. des Bouvets
92000 Nanterre C
Phone: 33 (17) 76 13 53
Telex: (842) 613737 TEKNANT

**Aix-en-Provence Region Center**
Immeuble Tertia 1-Z.I.D'AIX
13763 Les-Milles Cedex
Phone: (42) 24 45 03
Telex: 440045

**Bordeaux Region Center**
Avenue J.F. Kennedy
Parc Club Cadera BT T
33700 Merignac
Phone: 33 (56) 34 27 03
Telex: (842) 570247

**Lyon Region Center**
163, Bd. des Etats-Unis
69008-Lyon
Phone: 33 (78) 76 40 03
Telex: (842) 300150 TEKLYON

**Rennes Region Center**
103A, Avenue de Crimee
35000 Rennes
Phone: 33 (99) 51 21 16
Telex: (842) 740829 TEKREN

**Strasbourg Region Center**
1, Rue du Marechal Lefebvre
67100 Strasbourg
Phone: 33 (88) 39 49 35
Telex: (842) 890470 TEKSTBG

**Toulouse Region Center**
Peri-Sud 2, Z.I. du Palays
13 Rue Villet Bat. 1
31400 Toulouse
Phone: 33 (61) 80 25 69
Telex: (842) 530243 TEKTOUL F

## GERMANY, FEDERAL REPUBLIC OF
## Tektronix GmbH

**Cologne Office**
Mail: P.O. Box 101544
D-5000 Cologne 1
Site: Sedanstrasse 13-17
Phone: 49 (221) 7722-0
Telex: (841) 8885417 ATEK D
Fax: 49 (221) 7722-362

**Berlin Office**
Ernst-Reuter-Platz 3-5
D-1000 Berlin 10
Phone: 49 (30) 313-9081
Telex: (841) 185804 TEKB D

**Cologne Service Center**
Schoenhauser Strasse 64
D-5000 Cologne 51
Phone: 49 (221) 37981
Telex: (841) 8885541 TEKC D

**Hamburg Office**
Kieler Strasse 407
D-2000 Hamburg 54
Phone: 49 (40) 54830
Telex: (841) 213749 TEKH D

**Karlsruhe Office**
Kriegsstrasse 39
D-7500 Karlsruhe 1
Phone: 49 (721) 37210
Telex: (841) 7825301 TEKK D
Fax: 49 (721) 374810

**Munich Office**
Ehrenbreitsteiner Strasse 36
D-8000 Munich 50
Phone: 49 (89) 14851
Telex: (841) 522953 TEKM D
Fax: 49 (89) 148-5250

**Nuremburg Office**
Donaustrasse 36
D-8500 Nuremberg 60
Phone: 49 (911) 646081
Telex: (841) 626255 TEKN D

## GREECE
## Eltronics, Limited

2, Alopekis Street
Athens 139
Phone: 30 (1) 721-0669/-1860,
724-9511/2/3/4/5
Telex: (863) 216435 DALM GR
(863) 216589 RADX GR

## GUERNSEY
## Tektronix Limited

Mail: P.O. Box 36
Guernsey, Channel Islands
Site: The Albany
South Esplanade
St. Peter Port
Phone: 44 (481) 26411, 711211
Telex: (851) 4191193 TEKGNY G
Fax: 44 (481) 35403

## HONG KONG
## Schmidt & Co. (H.K.) Limited

18th Floor, Great Eagle Centre
23 Harbour Road,
Wanchai
Phone: 852 (5) 833-0222
Telex: (780) 74766 SCHMC HX

## ICELAND
## Kristjan O. Skagfjord Limited (KOS)

Holmaslod 4
P.O. Box 906
121 Reykjavik
Phone: 354 (1) 24120
Telex: 2133 KOS I

## INDIA
## Hinditron Services Pvt. Limited

**Bombay Office**
69/A, L. Jagmohandas Marg
Bombay 400 006
Phone: 91 (22) 812-1316/-1615/-5344
822-1529
Telex: (953) 0112326 HSPL IN

**Bangalore Office**
33/44A Raj Mahal Vilas Extension
8th Main Road
Bangalore 560 080
Phone: 91 (812) 33139
Telex: (953) 0845741 HSPL IN

**Calcutta Office**
5th Floor
Castle House
5/1-A Hungerford Street
Calcutta 700 017
Phone: 91 (33) 432628, 447541
Telex: (953) 0214153 HSPL IN

**Madras Office**
223 Shivalaya Apt. B, 2nd Floor
Commander-In-Chief Road
Madras 600 105

**New Delhi Office**
204-5-6 Hemkunt Tower
98, Nehru Place
New Delhi 110 019
Phone: 91 (11) 641-0380/-4493

**Secunderabad Office**
Srinath Complex Limited.
5th Floor
Emerald House
Sarojini Devi Road
Secunderabad 500 003
Phone: (0842) -823751/-821117
Telex: 1556-973 HCPL IN

## INDONESIA
## P.T. Dwi Tunggal Jaya Sakti

Mail: P.O. Box 4435
Jakarta
Site: Wisma Harapan Bldg., 14th Fl.
Jalan Sudirman Kav 34
Jakarta
Phone: 62 (021) 584-685/-686
587-001 Ext 334
Telex: (796) 45356 HARAPAN IA

## IRELAND
## Tektronix U.K. Limited

Deans Grange Estate
Kill Lane
Black Rock,
County Dublin
Ireland
Phone: 44 (1) 850-166/-874
Telex: (852) 90478 TEKX EI

## ISRAEL
## Eastronics Limited

Mail: P.O Box 39300
Tel Aviv 61392
Site: 11 Rozanis Street
Tel-Baruch
Phone: 972 (3) 475151
Telex: 342610 DATIX IL
(922) 33638 RONIX IL

## ITALY
## Tektronix S.p.A.

**Milan Office**
Via Lampedusa 13
20141 Milan
Phone: 39 (2) 8466-946/-446
Telex: (843) 315217 TEK MIL I
Fax: 39 (2) 8490-665

**Rome Office**
Piazza Antonio Baldini 45
00141 Rome
Phone: 39 (6) 8278-041/-044
Telex: (843) 616018 TEKROM I

**Turin Office**
Via Cardinal M. Fossati 5
10141 Turin
Phone: 39 (11) 3351143, 372163
Telex: (843) 212543 TEKTOR I

## JAPAN
## Sony/Tektronix Corporation

Mail: P.O. Box 5209
Tokyo Int'l, Tokyo 100-31
Site: 9-31, Kitashinagawa - 5,
Shinagawa-ku
Tokyo 141
Phone: 81 (3) 448-4611
Telex: (781) 2422850 STTYO J
Fax: 81 (3) 444-0318

**Atsugi Field Office**
Green Kaikan
1-8-14 Asahi-cho
Atsugi 243
Phone: 81 (462) 28-6768

**Fukuoka Office**
Nihon Seimei Hakataekimae Bldg.
2-1 Hakataekimae-3,
Hakata-ku
Fukuoka 812
Phone: 81 (92) 472-2626

**Nagoya Office**
Sanko Building
21-7 Meieki 3-Chome,
Nakamura-ku
Nagoya 450
Phone: 81 (52) 581-3547

**Osaka Office**
Osaka Ohbayashi Building
3-Kyobashi, Higaski-ku
Osaka 450
Phone: 81 (6) 947-0321

**Sendai Office**
Yamato Seimei Sendai Bldg.
1-30 Ichibancho-1
Sendai 980
Phone: 81 (222) 67-2181

**Tama Field Office**
2-45-10 Fujimidai
Kunitachi Tokyo 186
Phone: 81 (425) 73-2111

**Tsuchiura Office**
Sumitomo Seimei Tsuchiura Bldg.
16-12 Sakuracho-1
Tsuchiura 300
Phone: 81 (298) 24-2602

## JORDAN
## Consult-Tel

P.O. Box 35055
Amman
Phone: 962 (6) 636668
Telex: 22345 CONSLT JO

## KOREA
## Myoung Corporation

Mail: CPO Box 8892
Seoul
Site: Rm 1501 Singson Bldg.
25-4 Yoido-Dong
Youngdeungpo-Ku
Phone: 82 (2) 784-9942
Telex: (787) 24283 MYOUNG K

## KUWAIT
## Tareq Company Limited

P.O. Box Safat 20506
Phone: 965 () 243-6100/-6045
244-8100/-8101
Telex: 22315 ZUAITER KT

## LEBANON
## Projects S.A.L.

P.O. Box 11-5281
Beirut
Phone: 961 () 331680
Telex: 20466 LE

## MALAYSIA
## Mecomb Malaysia Sdn. Bhd.

(All Products Except IDG)
Mail: P.O. Box 24
Selangor
Site: No. 20 Jalan 225
Petaling Jaya
Phone: 60 (3) 743422
Telex: (784) 37764 MECOMB MA

## Sime Darby Systems

(IDG Products Only)
Wisma Sime Darby
Jalan Raja Laut
Kuala Lumpur
Phone: 60 (03) 939322
Telex: (784) 30038 SDMAL MA

## MEXICO
## Tektronix S.A. de C.V.

Viena No. 71-Piso 1
Col. Del Carmen, Coyoacan
04100 Mexico, D.F.
Phone: (905) 658-6211
Telex: (383) 1772962 TEK ME

## THE NETHERLANDS
## Tektronix Holland N.V.

Mail: P.O. Box 226
2130 AE Hoofddorp
Site: Planetenweg 99
2130 HL Hoofddorp
Phone: 31 (2503) 13300
Telex: (844) 74898 TEKSO NL

## NIGERIA
## Obodex Nigeria Limited

Mail: P.O. Box 6352
Lagos
Site: 21A Airport Road
Ikeja Lagos
Phone: 234 (1) 962125
Telex: 26744 DATA NG

## NEW ZEALAND
## Northrop Instruments Systems Limited

(T&M and IDG Products)
Mail: P. O. Box 9464,
Newmarket
Auckland 1
Site: 459 Kyber Pass Road,
Phone: 64 (9) 501-801/-219,
545-065
Telex: (791) 21570 THERMAL NZ

**Wellington Office**
Mail: P.O. Box 2406
Wellington
Site: 5th Floor, Westbrook House
189-191 Willis Street
Phone: 64 (4) 856-658
Telex: (791) 3440 CONSULT NZ

## NORWAY
## Tektronix Norge A/S

Brobekkveien 53
P.O. Box 106 Risloekka
0516 Oslo 5
Phone: 47 (2) 645770
Telex: (856) 77690 TEK N
Fax: 47 (2) 644704

## OMAN, SULTANATE OF
## OHI Telecommunications LLC

P.O. Box 889
Muscat
Phone: 968 () 603-606/-607/-608
Telex: 5052 TELECOM ON

## PAKISTAN
### Pak-Land Corporation Limited
(T&M Products Only)
Central Commercial Area
Igbal Road
P.E.C.H. Society
Karachi-29
Phone: 92 (21) 43-7315/-8084
Telex: (952) 25230 JALAL PK

## PANAMA
### Executive Marketing Corp.
Apartado 4929
Panama 5
Phone: 507 () 636-613/-644
Telex: (368) 3483 ELECTRON PA

## PERU
### Importaciones y Representaciones Electronicas S.A. (IRE Ingenieros)
(T&M Products Only)
Avda. Franklin D. Roosevelt 105
Edificio Rimac
Lima
Phone: 51 (14) 28-86-50, 27-20-76
Telex: (394) 25663 IREING PU

## PHILIPPINES
### Philippine Electronic Industries, Inc.
Mail: P.O. Box 498
Makati Commercial Centre
Makati, Metro Manila 3117
Site: 3rd Floor, Rose Industries Bldg.
11 Pioneer Street
Pasig, Metro Manila
Phone: 63 (2) 637-4321
Telex: (742) 43109 PEI PM

## PORTUGAL
### Decada Espectral Equipamentos De Electronica E Cientificos, SARL
Mail: Miraflores/Alges
1495 Lisbon
Site: Av. Bombeiros Voluntarios, Lote 102B
Phone: 351 (19) 2103420
Telex: 15515 ESPEC P

## QATAR
### Business Communications Qatar
P.O. Box 3656
Doha
Phone: 974 () 325-851/-164
Telex: 4454 BCQ DH

## SAUDI ARABIA, KINGDOM OF
### Al Rushaid Trading Co.
**Al Khobar Office**
Mail: P.O. Box 540
Dhahran Airport 31932
Site: Al Rushaid Building
Opposite Royal Hotel
Prince Hamoud Street
Akrabiya, Al Khober
Phone: 966 (3) 898-0027/-0028
Telex: 670723 RUSH SJ

**Riyadh Office**
Mail: P.O. Box 58791
Riyadh 11515
Site: Suite 4302
4th Floor, 3rd Pavillion
The New Akaria Building
Sitteen Street
Riyadh
Phone: 966 (1) 478-5327/-8328
Telex: 206434 RUSHID SJ

## SINGAPORE
### Mecomb Singapore Limited
(All Products Except IDG)
Sime Darby Centre
896 Dunearn Road, #04-02
Singapore 2158
Phone 65 () 469-88 33
Telex: (786) RS-23178

### Sime Darby Systems
(IDG Products Only)
Sime Darby Centre #04-05
896 Dunearn Road
Singapore 2158
Phone: 65 () 469-8822
Telex: (786) 28450 SDCOMP RS

## SOUTH AFRICA, REPUBLIC OF
### Protea P.N.I. Pty. Limited
**Johannesburg Office**
Mail: P.O. Box 39127
Bramley 2018
Transvaal
Site: 746 6th Street
Wynberg, Sandton 2199
Phone: 27 (11) 786-3547
Telex: 4-24409 SA

**Capetown Office**
P.O. Box 12
Goodwood 7460
Cape
Phone: 27 (21) 98-3439
Telex: 5-77551 SA

**Durban Office**
Mail: P.O. Box 47031
Greyville 4023
Natal
Site: 3 Florida Centre
273 Florida Road
Freyville 4001
Durban
Phone: 27 (31) 39-1100
Telex: 60981 SA

## SPAIN
### Tektronix Espanola S.A.
**Madrid Office**
Calle Condesa de Venadito 1-5°
28027 Madrid
Phone: 34 (1) 404-1011
Telex: (831) 46014 TKME E
Fax: 34 (1) 404-0997

**Barcelona Office**
Gran Via Carlos III, 97 G
08028 Barcelona
Phone: 34 (3) 330-2008
Telex: (831) 97398 TKBE E

## SRI LANKA
### Computerlink Data Systems, Limited
(T&M and IDG Products)
294 Union Place
Colombo 2
Phone: 94 (1) 2864-1/-2
Telex: (954) 21321 INLINK CE

## SWEDEN
### Tektronix AB
**Stockholm Office**
Mail: Box 4205
S-171 04 Solna
Site: Anderstorpsvagen 12
Phone: 46 (8) 830080
Telex: (854) 17831 TEKSWED S
Fax: 46 (8) 839430

**Gothenburg Office**
Sveagaten 3-9
S-413 14 Gothenburg
Phone: 46 (031) 427035

## SWITZERLAND
### Tektronix International A.G.
Mail: P.O. Box 2142
CH-6300 Zug 2
Site: Gubelstrasse 11
Phone: 41 (42) 219192
Telex: (845) 868808 TEKZ CH
Fax: 41 (42) 217784

## SYRIA
### General Trading Co.
(T&M and IDG Products)
Mail: P.O. Box 798
Damascus
Site: Sanaa Street No. 3 Salhieh
Phone: 114807, 224170, 445678
Telex: GITCO 411283 SY

## TAIWAN
### Heighten Corporation
11th Floor
342 Min Sheng East Road
P.O. Box 46-65
Taipei, Taiwan 104
Phone: 551-9916 (10 lines)
542-0591/-0592
Telex: (785) 21472 HEIGHTEN

## THAILAND
### Dynamic Supply Engineering R.O.P.
(T&M Products Only)
12 Soi Pasana 1, Ekamai
Sukhumvit 63
Bangkok 10110
Phone: 66 (2) 392-5313/-8532,
391-9571/-7897
Telex: (788) 82455 DYNASUP TH

## TUNISIA
### Societe El Eslek
3 Rue de la Monnaie
1001 Tunis
Phone: 216 (1) 244372, 342003
Telex: (934) 13664 ESLEK TN

## TURKEY
### Erkman Elektronik Aletler
(T&M and IDG Products)
**Istanbul Office**
Ticaret Anonim Sirketi
Necatibey Caddesi 92/3
Karakoy, Istanbul
Phone: 90 (11) 44 1546/-7651
Telex: 24399 MSE TR

**Ankara Office**
Hatay Sok. 20-3
Kizilay, Ankara
Phone: 90 (41) 17-1512

## UNITED ARAB EMIRATES
### Mideast Data Systems U.A.E.
Mail: P.O. Box 7899
Abu Dhabi
Site: Ahmed Bin Ghannoum Bldg.
Salam Street
Abu-Dhabi
Phone: 971 (2) 724-700
Telex: 24325 MDSUAE EM

## UNITED KINGDOM
### Tektronix U.K. Limited
Fourth Avenue
Globe Park
Marlow,
Bucks SL7 1YD
Phone: 44 (6284) 6000
Telex: (851) 847277, 847378 TEKMAR G
Fax: 44 (6284) 74799

**Harpenden Office**
Mail: P.O. Box 69
Harpenden
Herts AL5 4UP
Site: Beaverton House
36-38 Coldharbour Lane
Phone: 44 (5827) 63141
Telex: (851) 25559 TEKHPN G

**Manchester Office**
Sovereign House
232/234 Stockport Road
Cheadle, Stockport SK8 2EA
Phone: 44 (61) 428-0799
Telex: (851) 668409 TEKMCR G

**Scotland Office**
Pentland House
Almonvale South
Livingston,
West Lothian, EH54 6NG
Scotland
Phone: 44 (506) 37266
Telex: (851) 727056 TEKLIV G

## URUGUAY
### Coasin Uruguaya S.A.
(T&M and IDG Products)
Mail: Casilla De Correos 1400
Correo Central
Montevideo
Site: Libertad 2529
Phone: 598 (2) 78-9015/-9204
Telex: UY 23010 COAUR

## VENEZUELA
### Equilab, C.A.
(T&M and IDG Products)

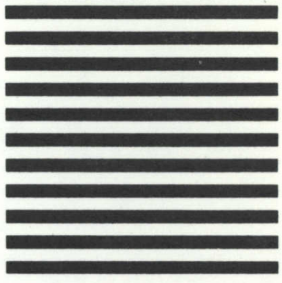
**Caracas Office**
Mail: Apartado 76609
Caracas 1070-A
Site: Centro Sequros La Paz, Of. E-61
Avda Feo de Miranda, Boleita
Caracas 1070
Phone: 58 (2) 34-4626/-1777/-5068
Telex: 21860 EQUIX VENEZUELA

**Maracaibo Office**
Mail: Apartado 1949
Maracaibo 4001-A
Site: Centro Comercial Montielco
Oficina 4, Piso 5
Avda 5 de Julio con calle 72
Maracaibo
Phone: 58 (61) 52-4578/-7490
Telex: 62154 EQUIX

## ZIMBABWE
### Protea Medical Services (Pvt) Limited
Mail: P.O. Box 2766
Harare
Site: 111 Kelvin Road South
Graniteside
Harare
Phone: 263 (0) 704094
Telex: 4102 PROTAZW

PRINTED IN CANADA

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

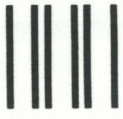


BUSINESS REPLY MAIL

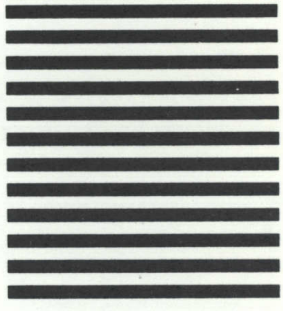
FIRST CLASS PERMIT NO. 1 BEAVERTON, OR

POSTAGE WILL BE PAID BY ADDRESSEE

**Tektronix, Inc.**
**Attn: Fulfillment**
P.O. Box 1700
Beaverton, Oregon 97075



NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

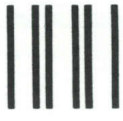


BUSINESS REPLY MAIL

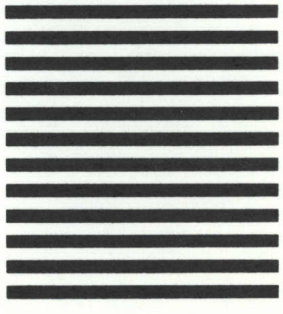
FIRST CLASS PERMIT NO. 1 BEAVERTON, OR

POSTAGE WILL BE PAID BY ADDRESSEE

**Tektronix, Inc.**
**Attn: Fulfillment**
P.O. Box 1700
Beaverton, Oregon 97075



NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES



BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 1 BEAVERTON, OR

POSTAGE WILL BE PAID BY ADDRESSEE

**Tektronix, Inc.**
**Attn: Fulfillment**
P.O. Box 1700
Beaverton, Oregon 97075

(Please type, print or write legibly.)

Send me information on:

☐ _____ Product Applications
☐ Customer Training for _____ Products
☐ Tektronix Service Programs for _____ Products

Name_____

Title_____

Firm _____ Phone (  )_____

Address_____

City_____ State _____ Zip_____

Also, please:
☐ Add me to your mail list.
☐ Drop me from your mail list.
☐ Send me the 1986 Catalog of all Tektronix products.
☐ Send me the 1985/86 Television Products Catalog.

Tektronix®
COMMITTED TO EXCELLENCE

D836-11-AXX

**Please have a Sales Representative contact me regarding**_____

(Please type, print or write legibly.)

Send me information on:

☐ _____ Product Applications
☐ Customer Training for _____ Products
☐ Tektronix Service Programs for _____ Products

Name_____

Title_____

Firm _____ Phone (  )_____

Address_____

City_____ State _____ Zip_____

Also, please:
☐ Add me to your mail list.
☐ Drop me from your mail list.
☐ Send me the 1986 Catalog of all Tektronix products.
☐ Send me the 1985/86 Television Products Catalog.

Tektronix®
COMMITTED TO EXCELLENCE

D836-11-AXX

**Please have a Sales Representative contact me regarding**_____

(Please type, print or write legibly.)

Send me information on:

☐ _____ Product Applications
☐ Customer Training for _____ Products
☐ Tektronix Service Programs for _____ Products

Name_____

Title_____

Firm _____ Phone (  )_____

Address_____

City_____ State _____ Zip_____

Also, please:
☐ Add me to your mail list.
☐ Drop me from your mail list.
☐ Send me the 1986 Catalog of all Tektronix products.
☐ Send me the 1985/86 Television Products Catalog.

Tektronix®
COMMITTED TO EXCELLENCE

D836-11-AXX

## ALABAMA

**Huntsville 35805**
4900 Corporate Drive
Suite H
Phone: (205) 830-9212

## ARIZONA

**(Phoenix)**
3015 S. 48th Street, Suite 100
**Tempe 85282**
Phone: (602) 438-1011
Tucson Area: (602) 790-3099
**Mailing Address:**
P.O. Box 29540
**Phoenix 85038**

## CALIFORNIA

**(Concord)**
3451 Vincent Road
**Pleasant Hill 94523**
Phone: (415) 932-4949
From Oakland/San Francisco: (415) 254-5353
From Sacramento: (916) 447-5072
From Fremont/Milpitas: (415) 490-7067
From Livermore: (415) 449-5176
**Mailing Address:**
P.O. Box 4040
**Concord 94524-2040**

**Irvine 92714**
17052 Jamboree Blvd.
**Mailing Address:**
P.O. Box 19523
Irvine 92713
Phone: (714) 660-8080
TELEFAX: (GP1)(714) 660-8080 X311

**(Los Angeles)**
21300 Erwin Street
**Service Center**
20920 Victory Blvd.
**Woodland Hills 91367**
Phone: (818) 999-1711
**Mailing Address:**
P.O. Box 8500
**Woodland Hills 91365**

**San Diego 92123**
5770 Ruffin Road
Phone: (619) 292-7330

**Santa Clara 95054-1196**
3003 Bunker Hill Lane
Phone: (408) 496-0800
TELEFAX: (GP 1) (408) 496-0800

## COLORADO

**(Denver)**
393 Inverness Drive South
**Englewood 80112**
Phone: (303) 799-1000
Telex: (Infocom) 45-4455
From Colorado Springs: (303) 634-3933

## CONNECTICUT

**Milford 06460**
40 Commerce Park Road
Phone: (203) 877-1494

## FLORIDA

**Fort Lauderdale 33309**
2003 N.W. 62nd Street
(known as) Cypress Creek Road
Phone: (305) 771-9700
From Miami: (305) 947-6053
Also serves Puerto Rico and
U.S. Virgin Islands

**Orlando 32803**
3657 Maguire Blvd., Suite 100
Phone: (305) 894-3911
From the Cape Kennedy Area:
(305) 636-0343

**Pensacola 32503**
4700 Bayou Blvd., Bldg. 1
Phone: (904) 476-1897

## GEORGIA

**(Atlanta)**
Technology Park/Atlanta
650 Engineering Drive
**Norcross 30092**
Phone: (404) 449-4770
**Mailing Address:**
P.O. Box 6500
**Norcross 30091**

## HAWAII

**Honolulu Service Center 96819**
EMC Corporation
550 Paiea Street
Phone: (808) 836-1138 (Service)
(800) 538-8125/6 (Sales)

## ILLINOIS

**(Chicago)**
5350 Keystone Court
**Rolling Meadows 60008**
Phone: (312) 259-7580
TELEFAX: (GP 1) (312) 259-7580

## INDIANA

**Indianapolis 46268**
8751 Wesleyan Road
Phone: (317) 872-3708

## KANSAS

**(Kansas City)**
10580 Barkley, Suite 62
**Overland Park 66212**
Phone: (913) 341-3344
Omaha, Lincoln, Wichita
ENterprise 6537

## LOUISIANA

**(New Orleans)**
1940 I-10 Service Rd.
Concourse Place
**Kenner 70065**
Phone: (504) 466-4445

## MARYLAND

**(Baltimore)**
102 Lakefront Dr.
**Cockeysville 21030**
Phone: (301) 628-6400

**DC**
700 Professional Drive
P.O. Box 6026
**Gaithersburg 20877**
Phone: (301) 948-7151
TELEFAX: (GP 1) (301) 948-7151 X321

## MASSACHUSETTS

**(Boston)**
482 Bedford Street
**Lexington 02173**
Phone: (617) 861-6800

## MICHIGAN

**(Detroit)**
24155 Drake Road
**Farmington 48024**
Phone: (313) 478-5200

## MINNESOTA

**St. Paul 55126**
4660 Churchill Street
Phone: (612) 484-8571

## MISSOURI

**(St. Louis)**
2318 Millpark Dive
**Maryland Heights 63043**
Phone: (314) 429-7707

## NEW JERSEY

**Woodbridge 07095**
40 Gill Lane
Phone: (201) 636-8616
TELEFAX: (GP 1) (201) 636-8616 X266

## NEW MEXICO

**Albuquerque 87108**
1258 Ortiz Drive, S.E.
Phone: (505) 265-5541
Southern N.M. Area: ENterprise 678
Southern Nevada Area:ENterprise 678
El Paso, TX ENterprise 678
TELEFAX: (GP 1) (408) 358-3421

## NEW YORK

**Albany 12205**
26 Computer Drive West
Phone: (518) 458-7291

**(Long Island)**
100 Crossways Park West
**Woodbury, L.I. 11797**
Phone: (516) 364-9060
NYC Customers (718) 895-9215

**Poughkeepsie 12601**
Beechwood Office Park
385 South Road
Phone: (914) 454-7540

**Rochester 14623**
1210 Jefferson Road
Phone: (716) 424-5800

**(Syracuse)**
1 Northern Concourse
**North Syracuse 13212**
Phone: (315) 455-6661

## NORTH CAROLINA

**Raleigh 27612**
3725 National Drive, Suite 104
Phone: (919) 782-5624

## OHIO

**(Cleveland)**
7830 Freeway Circle
**Middleburg Heights 44130**
Phone: (216) 243-8500 (Sales)
(216) 243-8505 (Service)

**Dayton 45449-2396**
501 Progress Rd.
Phone: (513) 859-3681

## OKLAHOMA

**Oklahoma City 73108**
4400 Will Rogers Parkway
Suite 220
Phone: (405) 943-8127
Oklahoma Wats Only
Phone: (800) 522-8196

## OREGON

10220 S.W. Nimbus Drive
Suite K-4
**Portland 97223**
Phone: (503) 620-9100

**Factory Service Center**
Tektronix Industrial Park
**Beaverton 97077**
Phone: (503) 642-8600
TWX: (910) 467-8708
TLX: 15-1754

## PENNSYLVANIA

**(Philadelphia)**
450 Sentry Parkway
**Blue Bell 19422**
Phone: (215) 825-6400

**Pittsburgh 15221**
1051 Brinton Road, Suite 300
Phone: (412) 244-9800

## TENNESSEE

**Knoxville 37923**
9041 Executive Park Drive
Suite 411
Phone: (615) 690-6422
From Oak Ridge (615) 482-7349

## TEXAS

**(Dallas)**
1551 Corporate Drive
**Irving 75038**
**Mailing Address:**
P.O. Box 165027
**Irving 75016**
Phone: (214) 258-0525
Metro: (214) 256-5534
TELEFAX: (GP 1) (214) 258-0525 X256

**Houston 77099**
10887 S. Wilcrest Drive
Phone: (713) 933-3000
**Mailing Address:**
P.O. Box 4309
**Houston 77210**

**San Antonio 78232**
14800 San Pedro Avenue
Suite 112
Phone: (512) 496-1161

**Kelly 78226**
Billy Mitchell Center
227 Billy Mitchell Road
Phone: (512) 432-1341

## UTAH

**Salt Lake City 84115**
Timesquare Park
300 Mercer Way
Phone: (801) 486-1091

## VIRGINIA

**(Crystal City)**
Hayes Building
Suite 1004
2361 S. Jefferson Davis Hwy.
**Arlington 22202**
Phone: (703) 920-7770

**Newport News 23602**
606 Denbigh Blvd., Suite 703
Phone: (804) 874-0099

## WASHINGTON

**(Seattle)**
3709 157th Avenue NE.
**Redmond, WA 98052**
Phone: (206) 575-0180

---

## CORPORATE OFFICE

Tektronix, Inc.,
P.O. Box 500
**Beaverton, Oregon 97077**
Telephone: (503) 627-7111

## PRINCIPAL PLANT

Tektronix Industrial Park,
**Beaverton, Oregon 97077**

## DIRECT ORDER

For Continental United States, Alaska, Hawaii, Virgin Islands and Puerto Rico. Contact our National Marketing Center:
Phone: (800) 426-2200
For State of Oregon,
call collect (503) 627-9000.

## ADDITIONAL LITERATURE

or Tektronix Sales Office serving you:
P.O. Box 1700,
**Beaverton, Oregon 97075**
Phone: (800) 547-1512
Oregon only: (800) 452-1877
TLX: 151754,
TWX: (910) 467-8708
TEKTRONIX BEAV.

Sales Office Listing on 462-Inside Back Cover
Functional Index on pages 2-9
Alphanumeric Index on pages 10-12

40 YEARS

Tektronix®

COMMITTED TO EXCELLENCE